



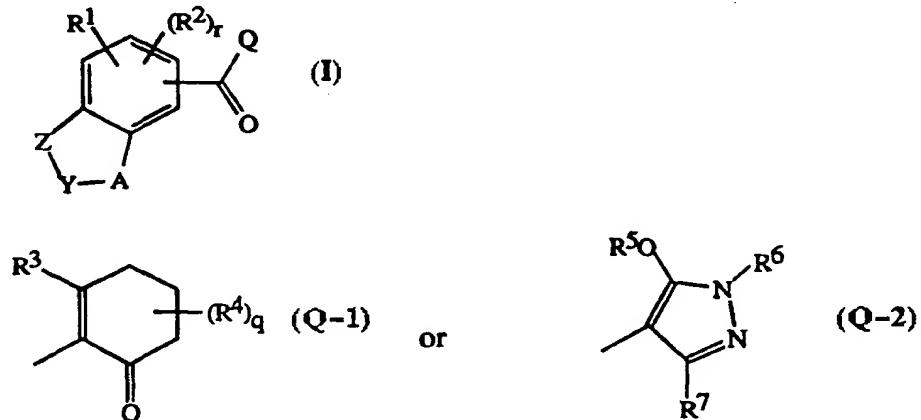
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(54) Title: BICYCLIC HERBICIDES

(57) Abstract

Compounds of Formula (I), and their agriculturally suitable salts, are disclosed which are useful for controlling undesired vegetation, wherein Q is (Q-1) or (Q-2); and A, Y, Z, R¹-R⁷, q and r are as defined in the disclosure. Also disclosed are compositions containing the compounds of Formula (I) and a method for controlling undesired vegetation which involves contacting the vegetation or its environment with an effective amount of a compound of Formula (I).



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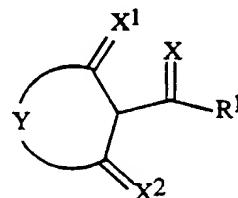
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TITLE
BICYCLIC HERBICIDES
BACKGROUND OF THE INVENTION

This invention relates to certain bicyclic compounds, their agriculturally suitable salts and compositions, and methods of their use for controlling undesirable vegetation.

The control of undesired vegetation is extremely important in achieving high crop efficiency. Achievement of selective control of the growth of weeds especially in such useful crops as rice, soybean, sugar beet, corn (maize), potato, wheat, barley, tomato and plantation crops, among others, is very desirable. Unchecked weed growth in such useful crops can cause significant reduction in productivity and thereby result in increased costs to the consumer. The control of undesired vegetation in noncrop areas is also important. Many products are commercially available for these purposes, but the need continues for new compounds which are more effective, less costly, less toxic, environmentally safer or have different modes of action.

EP 283,261 discloses cyclic diones of Formula I as herbicides:



i

wherein

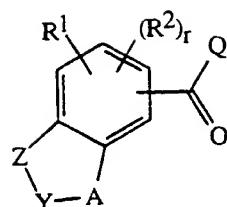
X, X¹ and X² are independently O or S;

R¹ is a monocyclic or fused-bicyclic heterocyclic group containing up to ten ring atoms up to five of which may be selected from O, N and S, optionally substituted with one or more groups selected from, among others, oxo, halogen, nitro, cyano, alkyl, haloalkyl, haloalkoxy, alkoxy, alkylsulfonyl; and Y is, among others, C₂-C₄ alkylene which is optionally substituted with one or more groups selected from, among others, halogen or alkyl.

The bicyclic herbicides of the present invention are not disclosed in this publication.

SUMMARY OF THE INVENTION

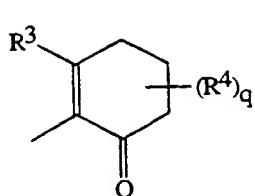
This invention is directed to compounds of Formula I including all geometric and stereoisomers, agriculturally suitable salts thereof, agricultural compositions containing them and their use for controlling undesirable vegetation:



I

wherein

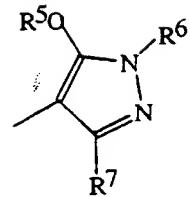
Q is



5

Q-1

or



Q-2

10 A is $-(CH_2)_m-$, $-CH=CH-$, $-CH_2CH=CH-$, $-CH=CHCH_2-$, $-(CH_2)_n-NR^9-$,
 $-NR^9-(CH_2)_n-$, $-(CH_2)_n-O-$ or $-(CH_2)_n-S(O)_2-$, each group optionally
substituted with one to four R^8 , and the directionality of the A linkage is
defined such that the moiety depicted on the left side of the linkage is bonded
to Y and the moiety on the right side of the linkage is bonded to the phenyl
ring;

15 Y is O; NR^9 ; or CH_2 optionally substituted with one or two groups independently
selected from C_1-C_6 alkyl, C_1-C_6 haloalkyl and halogen; provided that when
A is $-NR^9-(CH_2)_n-$, then Y is CH_2 ;

20 Z is $C(=X)$, O, or $S(O)_2$; provided that when Y is O or NR^9 , then Z is $C(=X)$;
X is O or S;
R¹ is H, C_1-C_6 alkyl, C_1-C_6 haloalkyl, C_1-C_6 alkoxy, C_1-C_6 haloalkoxy, halogen,
cyano, nitro, $S(O)_2NR^{10}R^{11}$, C_1-C_6 alkylsulfonyl, C_1-C_6 haloalkylsulfonyl,
 C_3-C_6 alkenylsulfonyl, C_3-C_6 haloalkenylsulfonyl, C_3-C_6 alkynylsulfonyl,
 C_3-C_6 haloalkynylsulfonyl or C_3-C_6 cycloalkylsulfonyl; or R¹ is
phenylsulfonyl optionally substituted with C_1-C_3 alkyl, C_1-C_3 haloalkyl,
 C_1-C_3 alkoxy, C_1-C_3 haloalkoxy, 1-2 halogen, cyano or nitro;
each R² is independently C_1-C_6 alkyl, C_1-C_6 haloalkyl, C_1-C_6 alkoxy, C_1-C_6
haloalkoxy, halogen, cyano or nitro;

25

R³ is OR¹², C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl or halogen; each R⁴ is independently C₁-C₃ alkyl, C₁-C₃ alkoxy, C₁-C₃ alkylthio or halogen; or when two R⁴ are attached to the same carbon atom, then said R⁴ pair can be taken together to form -OCH₂CH₂O-, -OCH₂CH₂CH₂O-, -SCH₂CH₂S- or -SCH₂CH₂CH₂S-, each group optionally substituted with 1-4 CH₃;

5 R⁵ is H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkoxyalkyl, formyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxy carbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₇ dialkylaminocarbonyl, C₁-C₆ alkylsulfonyl or C₁-C₆ haloalkylsulfonyl; or R⁵ is 10 benzoyl or phenylsulfonyl, each optionally substituted with C₁-C₃ alkyl, halogen, cyano or nitro;

15 R⁶ is H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ alkenyl or C₃-C₆ alkynyl; or R⁶ is phenyl or benzyl, each optionally substituted on the phenyl ring with C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, 1-2 halogen, cyano or nitro;

15 R⁷ is H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, halogen, cyano or nitro;

20 each R⁸ is independently C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, hydroxy or halogen; or two R⁸ groups bonded to the same carbon atom can be taken together with the carbon to which they are attached to form C(=O) or C(=S); provided that when two R⁸ groups are attached to a carbon atom which is attached to an O, NR⁹ or S(O)₂, then no more than one of said R⁸ groups can be C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, hydroxy or halogen;

25 each R⁹ is independently H; C₁-C₆ alkyl; C₁-C₆ haloalkyl; C₃-C₆ alkenyl; C₃-C₆ haloalkenyl; C₃-C₆ alkynyl; C₃-C₆ haloalkynyl; C₃-C₆ cycloalkyl; C₁-C₆ alkoxy; C₁-C₆ haloalkoxy; C₂-C₆ alkoxyalkyl; formyl; C₂-C₆ alkylcarbonyl; C₂-C₆ alkoxy carbonyl; C₂-C₆ alkylaminocarbonyl; C₃-C₇ dialkylaminocarbonyl; or phenyl, benzyl or benzoyl, each optionally substituted on the phenyl ring with C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, 1-2 halogen, cyano or nitro;

30 R¹⁰ is H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ alkenyl, C₃-C₆ haloalkenyl, C₃-C₆ alkynyl, C₃-C₆ haloalkynyl, C₃-C₆ cycloalkyl or C₁-C₆ alkoxy; or R¹⁰ is phenyl or benzyl, each optionally substituted on the phenyl ring with C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, 1-2 halogen, cyano or nitro;

35 R¹¹ is H, C₁-C₆ alkyl or C₁-C₆ haloalkyl; or

R^{10} and R^{11} can be taken together as $-\text{CH}_2\text{CH}_2-$, $-\text{CH}_2\text{CH}_2\text{CH}_2-$, $-\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2-$, $-\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2-$ or $-\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2-$, each optionally substituted with 1-4 $C_1\text{-}C_3$ alkyl;

5 R^{12} is H, $C_1\text{-}C_6$ alkyl, $C_1\text{-}C_6$ haloalkyl, $C_2\text{-}C_6$ alkoxyalkyl, formyl, $C_2\text{-}C_6$ alkylcarbonyl, $C_2\text{-}C_6$ alkoxy carbonyl, $C_2\text{-}C_6$ alkylaminocarbonyl, $C_3\text{-}C_7$ dialkylaminocarbonyl, $C_1\text{-}C_6$ alkylsulfonyl or $C_1\text{-}C_6$ haloalkylsulfonyl; or R^{12} is benzoyl or phenylsulfonyl, each optionally substituted with $C_1\text{-}C_3$ alkyl, halogen, cyano or nitro;

10 m is 1, 2 or 3;

n is 1 or 2;

q is 0, 1, 2, 3 or 4; and

r is 0, 1 or 2;

provided that

15 (i) when Z is $C(=X)$ or O; A is $-(\text{CH}_2)_m-$ optionally substituted with one to four R^8 ; and m is 1 or 2; then Q is Q-2;

(ii) when Z is $C(=X)$ or O; and A is $-\text{CH}=\text{CH}-$ optionally substituted with one to two R^8 ; then Q is Q-2;

(iii) when Z is $C(=X)$ or O; A is $-(\text{CH}_2)_n\text{-NR}^9-$, $-\text{NR}^9\text{-}(\text{CH}_2)_n-$ or $-(\text{CH}_2)_n\text{-O-}$ each optionally substituted with one to four R^8 ; and n is 1; then Q is Q-2;

20 (iv) when A is $-(\text{CH}_2)_n\text{-NR}^9-$, $-(\text{CH}_2)_n\text{-O-}$ or $-(\text{CH}_2)_n\text{-S(O)}_2-$ each optionally substituted with one to four R^8 ; and Y is CH_2 optionally substituted with one or two groups independently selected from $C_1\text{-}C_6$ alkyl, $C_1\text{-}C_6$ haloalkyl and halogen; then Z is O or S(O)_2 ;

25 (v) when A is $-(\text{CH}_2)_m-$ optionally substituted with one to four R^8 ; Y is CH_2 optionally substituted with one or two groups independently selected from $C_1\text{-}C_6$ alkyl, $C_1\text{-}C_6$ haloalkyl and halogen; and Z is O or S(O)_2 ; then each R^8 is independently $C_1\text{-}C_6$ alkyl, $C_1\text{-}C_6$ haloalkyl, $C_1\text{-}C_6$ alkoxy, hydroxy or halogen provided that no more than one R^8 is $C_1\text{-}C_6$ alkoxy; and

30 (vi) when A is $-(\text{CH}_2)_m-$ optionally substituted with one to four R^8 ; Y is CH_2 optionally substituted with one or two groups independently selected from $C_1\text{-}C_6$ alkyl, $C_1\text{-}C_6$ haloalkyl and halogen; Z is S(O)_2 ; and m is 2; then Q is Q-1 and each R^8 is independently $C_1\text{-}C_6$ alkyl, $C_1\text{-}C_6$ haloalkyl, hydroxy or halogen.

35 In the above recitations, the term "alkyl", used either alone or in compound words such as "alkylthio" or "haloalkyl" includes straight-chain or branched alkyl, such as, methyl, ethyl, *n*-propyl, *i*-propyl, or the different butyl, pentyl or hexyl isomers. The term "1-4 alkyl" indicates that one to four of the available positions for that substituent may be alkyl which are independently selected. The term "1-4 CH_3 " indicates that one

to four of the available positions for that substituent may be methyl. "Alkenyl" includes straight-chain or branched alkenes such as 1-propenyl, 2-propenyl, and the different butenyl, pentenyl and hexenyl isomers. "Alkenyl" also includes polyenes such as 1,2-propadienyl and 2,4-hexadienyl. "Alkynyl" includes straight-chain or branched alkynes such as 1-propynyl, 2-propynyl and the different butynyl, pentynyl and hexynyl isomers. "Alkynyl" can also include moieties comprised of multiple triple bonds such as 2,5-hexadiynyl. "Alkoxy" includes, for example, methoxy, ethoxy, *n*-propyloxy, isopropyloxy and the different butoxy, pentoxy and hexyloxy isomers. "Alkoxyalkyl" denotes alkoxy substitution on alkyl. Examples of "alkoxyalkyl" include CH_3OCH_2 , $\text{CH}_3\text{OCH}_2\text{CH}_2$, $\text{CH}_3\text{CH}_2\text{OCH}_2$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OCH}_2$ and $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_2$.

"Alkylthio" includes branched or straight-chain alkylthio moieties such as methylthio, ethylthio, and the different propylthio, butylthio, pentylthio and hexylthio isomers. "Alkylsulfinyl" includes both enantiomers of an alkylsulfinyl group. Examples of "alkylsulfinyl" include $\text{CH}_3\text{S(O)}$, $\text{CH}_3\text{CH}_2\text{S(O)}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{S(O)}$, $(\text{CH}_3)_2\text{CHS(O)}$ and the different butylsulfinyl, pentylsulfinyl and hexylsulfinyl isomers. Examples of "alkylsulfonyl" include $\text{CH}_3\text{S(O)}_2$, $\text{CH}_3\text{CH}_2\text{S(O)}_2$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{S(O)}_2$, $(\text{CH}_3)_2\text{CHS(O)}_2$ and the different butylsulfonyl, pentylsulfonyl and hexylsulfonyl isomers. "Alkylamino", "dialkylamino", and the like, are defined analogously to the above examples. "Cycloalkyl" includes, for example, cyclopropyl, cyclobutyl, cyclopentyl, and cyclohexyl.

The term "halogen", either alone or in compound words such as "haloalkyl", includes fluorine, chlorine, bromine or iodine. The term "1-2 halogen" indicates that one or two of the available positions for that substituent may be halogen which are independently selected. Further, when used in compound words such as "haloalkyl", said alkyl may be partially or fully substituted with halogen atoms which may be the same or different. Examples of "haloalkyl" include F_3C , ClCH_2 , CF_3CH_2 and CF_3CCl_2 . The terms "haloalkenyl", "haloalkynyl", "haloalkoxy", and the like, are defined analogously to the term "haloalkyl". Examples of "haloalkenyl" include $(\text{Cl})_2\text{C}=\text{CHCH}_2$ and $\text{CF}_3\text{CH}_2\text{CH}=\text{CHCH}_2$. Examples of "haloalkynyl" include $\text{HC}\equiv\text{CCHCl}$, $\text{CF}_3\text{C}\equiv\text{C}$, $\text{CCl}_3\text{C}\equiv\text{C}$ and $\text{FCH}_2\text{C}\equiv\text{CCH}_2$. Examples of "haloalkoxy" include CF_3O , $\text{CCl}_3\text{CH}_2\text{O}$, $\text{HCF}_2\text{CH}_2\text{CH}_2\text{O}$ and $\text{CF}_3\text{CH}_2\text{O}$. Examples of "haloalkylthio" include CCl_3S , CF_3S , $\text{CCl}_3\text{CH}_2\text{S}$ and $\text{ClCH}_2\text{CH}_2\text{CH}_2\text{S}$. Examples of "haloalkylsulfinyl" include $\text{CF}_3\text{S(O)}$, $\text{CCl}_3\text{S(O)}$, $\text{CF}_3\text{CH}_2\text{S(O)}$ and $\text{CF}_3\text{CF}_2\text{S(O)}$. Examples of "haloalkylsulfonyl" include $\text{CF}_3\text{S(O)}_2$, $\text{CCl}_3\text{S(O)}_2$, $\text{CF}_3\text{CH}_2\text{S(O)}_2$ and $\text{CF}_3\text{CF}_2\text{S(O)}_2$.

The total number of carbon atoms in a substituent group is indicated by the " $\text{C}_i\text{-C}_j$ " prefix where i and j are numbers from 1 to 7. For example, $\text{C}_1\text{-C}_3$ alkylsulfonyl designates methylsulfonyl through propylsulfonyl; C_2 alkoxyalkyl designates CH_3OCH_2 ; C_3 alkoxyalkyl designates, for example, $\text{CH}_3\text{CH(OCH}_3)$, $\text{CH}_3\text{OCH}_2\text{CH}_2$ or $\text{CH}_3\text{CH}_2\text{OCH}_2$; and C_4 alkoxyalkyl designates the various isomers of an alkyl group

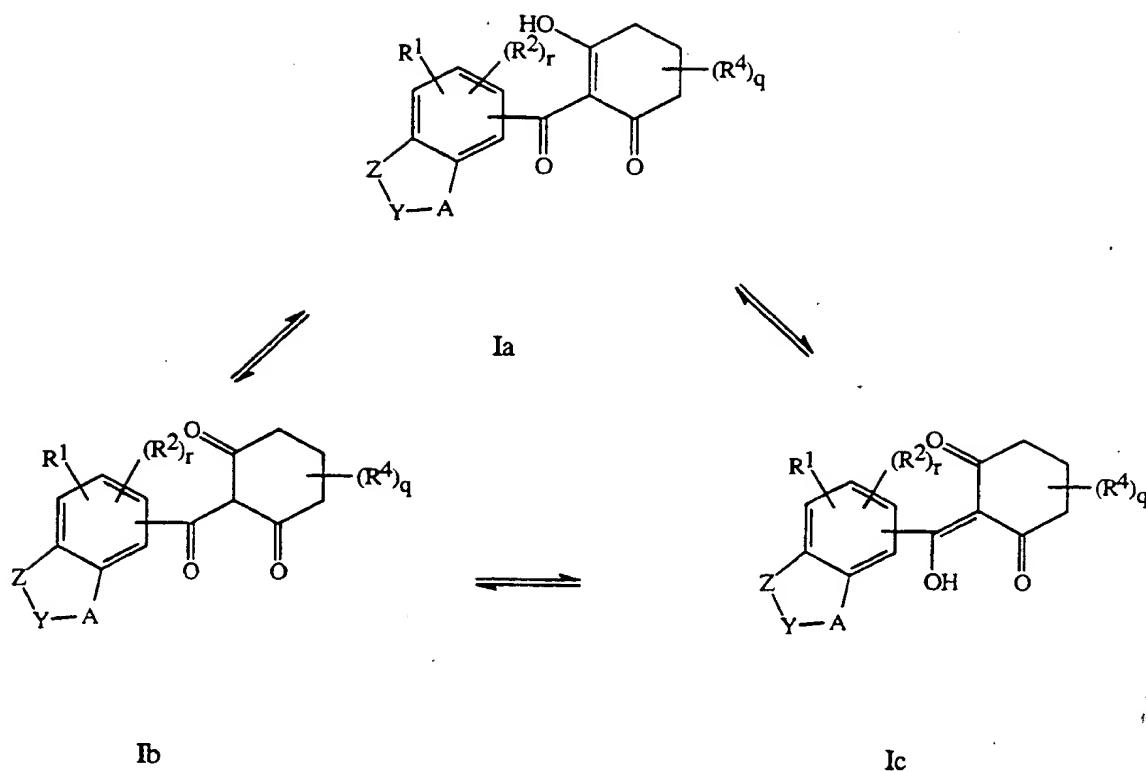
substituted with an alkoxy group containing a total of four carbon atoms, examples including $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_2$ and $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_2$. Examples of "alkylcarbonyl" include $\text{C}(\text{O})\text{CH}_3$, $\text{C}(\text{O})\text{CH}_2\text{CH}_2\text{CH}_3$ and $\text{C}(\text{O})\text{CH}(\text{CH}_3)_2$. Examples of "alkoxycarbonyl" include $\text{CH}_3\text{OC}(=\text{O})$, $\text{CH}_3\text{CH}_2\text{OC}(=\text{O})$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{OC}(=\text{O})$,
5 $(\text{CH}_3)_2\text{CHOC}(=\text{O})$ and the different butoxy- or pentoxy carbonyl isomers.

When a compound is substituted with a substituent bearing a subscript that indicates the number of said substituents can exceed 1, said substituents (when they exceed 1) are independently selected from the group of defined substituents. Further, when the subscript indicates a range, e.g. $(\text{R})_{i-j}$, then the number of substituents may be
10 selected from the integers between i and j inclusive.

When a group contains a substituent which can be hydrogen, for example R^1 or R^{12} , then, when this substituent is taken as hydrogen, it is recognized that this is equivalent to said group being unsubstituted.

Compounds of this invention can exist as one or more stereoisomers. The various
15 stereoisomers include enantiomers, diastereomers, atropisomers and geometric isomers. One skilled in the art will appreciate that one stereoisomer may be more active and/or may exhibit beneficial effects when enriched relative to the other stereoisomer(s) or when separated from the other stereoisomer(s). Additionally, the skilled artisan knows how to separate, enrich, and/or to selectively prepare said stereoisomers. Accordingly, the
20 present invention comprises compounds selected from Formula I and agriculturally suitable salts thereof. The compounds of the invention may be present as a mixture of stereoisomers, individual stereoisomers, or as an optically active form.

Some compounds of this invention can exist as one or more tautomers. One skilled in the art will recognize, for example, that compounds of Formula Ia (Formula I
25 where Q is Q-1, R^3 is OR^{12} , and R^{12} is H) can also exist as the tautomers of Formulae Ib and Ic as shown below. One skilled in the art will recognize that said tautomers often exist in equilibrium with each other. As these tautomers interconvert under environmental and physiological conditions, they provide the same useful biological effects. The present invention includes mixtures of such tautomers as well as
30 the individual tautomers of compounds of Formula I.



The salts of the compounds of the invention include acid-addition salts with inorganic or organic acids such as hydrobromic, hydrochloric, nitric, phosphoric, 5 sulfuric, acetic, butyric, fumaric, lactic, maleic, malonic, oxalic, propionic, salicylic, tartaric, 4-toluenesulfonic or valeric acids. The salts of the compounds of the invention also include those formed with organic bases (e.g., pyridine, ammonia, or triethylamine), or inorganic bases (e.g., hydrides, hydroxides, or carbonates of sodium, potassium, lithium, calcium, magnesium or barium) when the compound contains an acidic group 10 such as an enol.

Preferred compounds for reasons of better activity and/or ease of synthesis are:

Preferred 1. Compounds of Formula I above, and agriculturally suitable salts thereof, wherein:

the A-Y-Z moiety is selected from combinations of A, Y and Z such that

15 (i) when A is $-(CH_2)_m$ - optionally substituted with one to two R⁸ and Y is O or NR⁹, then Z is C(=X);

(ii) when A is $-(CH_2)_m$ - optionally substituted with one to two R⁸ and Y is CH₂ optionally substituted with one or two groups independently selected from C₁-C₆ alkyl, C₁-C₆ haloalkyl and halogen, then Z is O; and

20 (iii) when A is $-(CH_2)_m$ - or $-(CH_2)_n$ -NR⁹- optionally substituted with one to two R⁸ and Y is CH₂ optionally substituted with one or

two groups independently selected from C₁-C₆ alkyl, C₁-C₆ haloalkyl and halogen, then Z is S(O)₂;

5 X is O;

each R⁴ is independently C₁-C₃ alkyl;

R⁶ is H, C₁-C₆ alkyl or C₃-C₆ alkenyl;

R⁷ is H, C₁-C₃ alkyl or C₁-C₃ haloalkyl;

R⁹ is H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ alkenyl, C₃-C₆ alkynyl or C₃-C₆ cycloalkyl;

10 R¹² is H, formyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxycarbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₇ dialkylaminocarbonyl, C₁-C₆ alkylsulfonyl or C₁-C₆ haloalkylsulfonyl; or R¹² is benzoyl or phenylsulfonyl, each optionally substituted with C₁-C₃ alkyl, halogen, cyano or nitro;

15 q is 0, 1 or 2; and

r is 0 or 1.

Preferred 2. Compounds of Preferred 1 wherein:

R¹ is H, methyl, halogen, S(O)₂NR¹⁰R¹¹, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl or C₃-C₅ cycloalkylsulfonyl;

20 R² is methyl, halogen or nitro;

R³ is OR¹²;

R⁵ is H or C₁-C₃ alkylsulfonyl; or R⁵ is benzoyl or phenylsulfonyl, each optionally substituted with C₁-C₃ alkyl, halogen, cyano or nitro;

each R⁸ is independently C₁-C₃ alkyl, C₁-C₃ alkoxy or halogen; or two R⁸ groups bonded to the same carbon atom can be taken together with the carbon to which they are attached to form C(=O);

25 R¹⁰ is H, C₁-C₄ alkyl, allyl or propargyl;

R¹¹ is H or C₁-C₄ alkyl; and

R¹² is H or C₁-C₃ alkylsulfonyl; or R¹² is benzoyl or phenylsulfonyl, each optionally substituted with C₁-C₃ alkyl, halogen, cyano or nitro.

30 Most preferred are compounds of Preferred 2 selected from the group:

2-(1,1-dimethylethyl)-5-[(1-ethyl-5-hydroxy-1*H*-pyrazol-4-yl)carbonyl]-8-(ethylsulfonyl)-3,4-dihydro-1(2*H*)-isoquinolinone;

(2,3-dihydro-2,4,7-trimethylbenzo[*b*]thiophen-5-yl)(1-ethyl-5-hydroxy-1*H*-pyrazol-4-yl)methanone *S,S*-dioxide;

35 (1-ethyl-5-hydroxy-1*H*-pyrazol-4-yl)(2,3,4,5-tetrahydro-6,9-dimethyl-1-benzothiepin-7-yl)methanone *S,S*-dioxide;

4-ethyl-6-[(2-hydroxy-6-oxo-1-cyclohexen-1-yl)carbonyl]-2*H*-1,4-benzothiazin-3(4*H*)-one 1,1-dioxide;

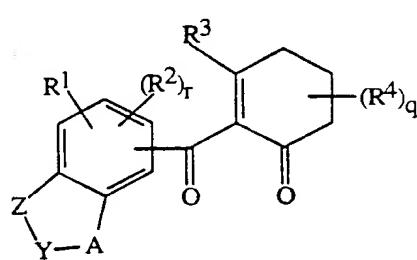
4-ethyl-6-[(2-hydroxy-6-oxo-1-cyclohexen-1-yl)carbonyl]-5,8-dimethyl-2*H*-1,4-benzothiazin-3(4*H*)-one 1,1-dioxide; and
 (2,3-dihydro-2,4,7-trimethylbenzo[*b*]thiophen-5-yl)(5-hydroxy-1-methyl-1*H*-pyrazol-4-yl)methanone *S,S*-dioxide.

5 This invention also relates to herbicidal compositions comprising herbicidally effective amounts of the compounds of the invention and at least one of a surfactant, a solid diluent or a liquid diluent. The preferred compositions of the present invention are those which comprise the above preferred compounds.

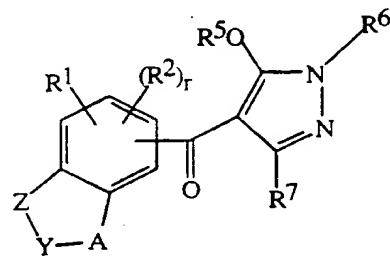
This invention also relates to a method for controlling undesired vegetation comprising applying to the locus of the vegetation herbicidally effective amounts of the compounds of the invention (e.g., as a composition described herein). The preferred methods of use are those involving the above preferred compounds.

DETAILS OF THE INVENTION

The compounds of Formula I can be prepared by one or more of the following methods and variations as described in Schemes 1-31. The definitions of Q, A, Y, Z, X, R¹-R¹², m, n, q and r in the compounds of Formulae 1-29 below are as defined above in the Summary of the Invention. Compounds of Formulae Ia-Ie are various subsets of the compounds of Formula I, and all substituents for Formulae Ia-Ie are as defined above for Formula I. Compounds of Formulae Id and Ie correspond to Formula I compounds wherein Q is Q-1 and Q-2, respectively.

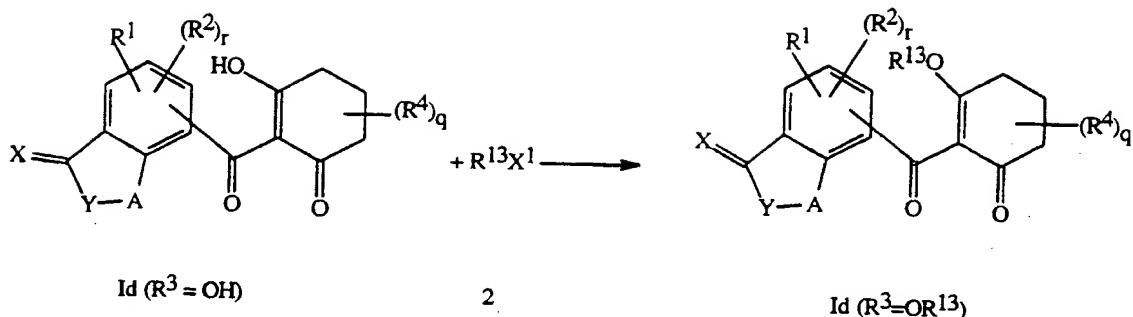


Id



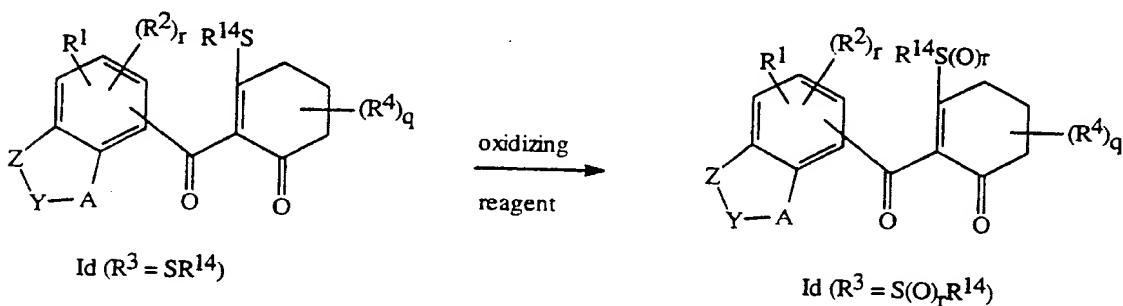
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Scheme 1 illustrates the preparation of compounds of Formula Id ($R^3 = OR^{13}$ and R^{13} is the same as R^{12} as described in the Summary of the Invention excluding H) whereby a compound of Formula Id ($R^3 = OH$) is reacted with a reagent of Formula 2 in the presence of a base wherein X^1 is chlorine, bromine, fluorine, methylsulfonyloxy (OMs), trifluoromethylsulfonyloxy (OTf), *p*-toluenesulfonyloxy (OTs) or acetoxy (OAc) and R^{13} is as previously defined. The coupling is carried out by methods known in the art (or by obvious modifications of these methods): for example, see K. Nakamura, et al., WO 95/04054.

Scheme 1

Scheme 2 illustrates the preparation of compounds of Formula Id ($R^3 = S(O)_r R^{14}$;

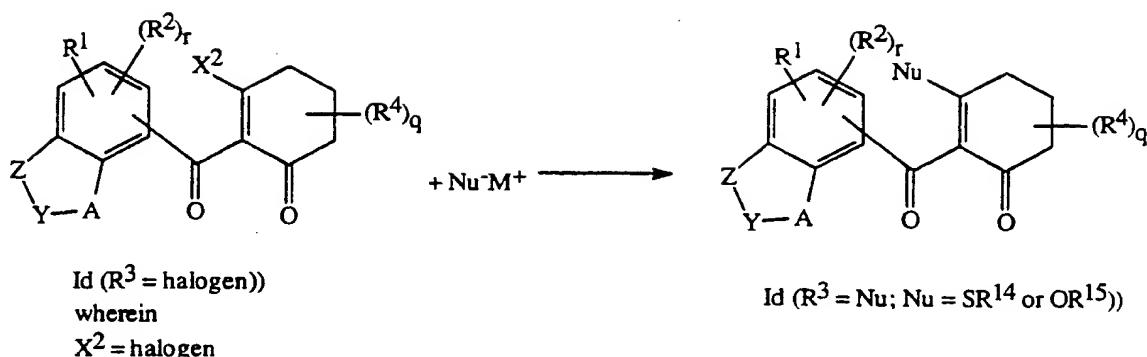
5 $r = 1$ or 2 ; and $R^{14} = C_1-C_6$ alkyl or C_1-C_6 haloalkyl) whereby a compound of
 Formula Id ($R^3 = SR^{14}$) is reacted with an oxidizing reagent such as peroxyacetic acid,
 m -chloroperoxybenzoic acid, peroxytrifluoroacetic acid, potassium peroxymonosulfate
 or hydrogen peroxide. The oxidation is carried out by methods known in the art (or by
 obvious modifications of these methods); for example, see S. Patai, et al., *The Chemistry*
 10 *of Sulphones and Sulphoxides*, John Wiley & Sons, 1988; pp 205-213, 235-253.

Scheme 2

Compounds of Formula Id ($R^3 = Nu$; $Nu = SR^{14}$ or OR^{15} ; R^{14} is as defined
 15 previously; R^{15} is C_1-C_6 alkyl, C_1-C_6 haloalkyl or C_2-C_6 alkoxyalkyl) can be prepared
 from a compound of Formula Id ($R^3 = \text{halogen}$) by treatment with a nucleophile of
 Formula 3 ($Nu = SR^{14}$ or OR^{15} ; $M = Na, K$ or Li) as shown in Scheme 3 using methods
 well documented in the literature (or obvious modifications of these methods): for
 example, see P. H. Nelson, et al., *Synthesis*, (1992), 12, 1287-1291; and S. Miyano, et
 20 al., *J. Chem. Soc. Perkin Trans*, (1976), 1, 1146.

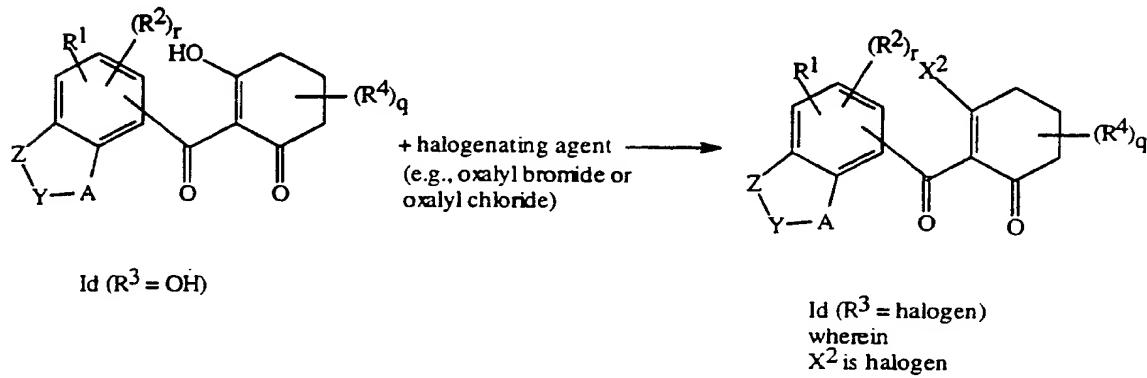
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Scheme 3



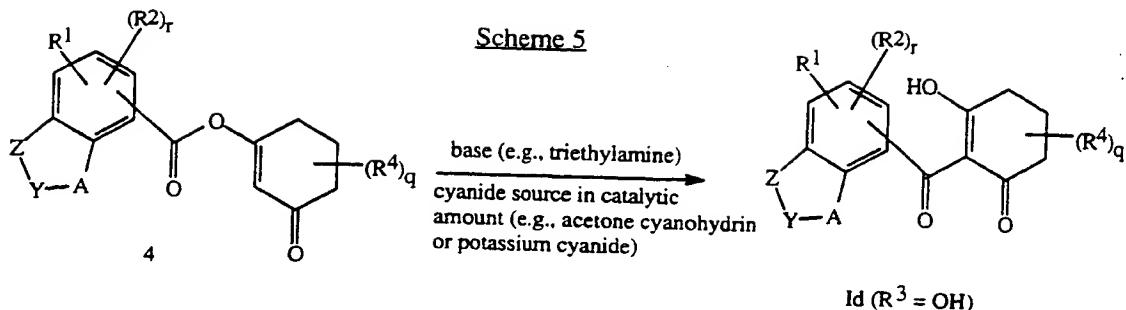
Compounds of Formula **Id** ($\text{R}^3 = \text{halogen}$) can be prepared by reacting a compound of Formula **Id** ($\text{R}^3 = \text{OH}$) with a halogenating reagent such as oxalyl bromide or oxalyl chloride (Scheme 4). This conversion is carried out by methods known in the art (or by obvious modifications of these methods): for example, see S. Muller, et al., 5 WO 94/13619; S. Muller, et al., DE 4,241,999.

Scheme 4



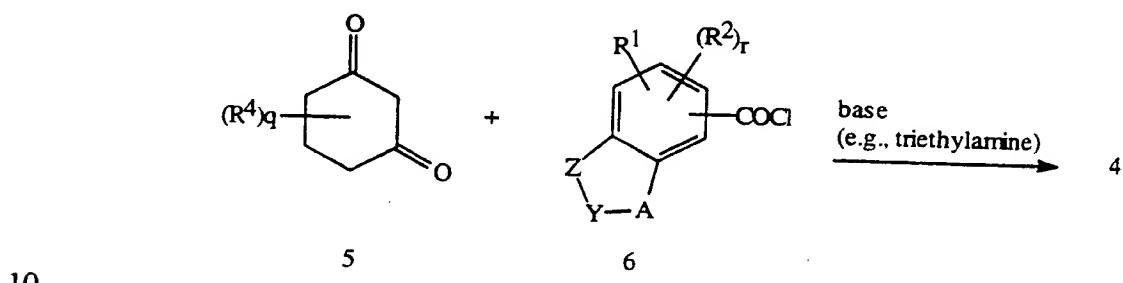
10

Scheme 5 illustrates the preparation of compounds of Formula **Id** ($\text{R}^3 = \text{OH}$) whereby an enol ester of Formula 4 is reacted with a base such as triethylamine in the presence of a catalytic amount of a cyanide source (e.g., acetone cyanohydrin or potassium cyanide). This rearrangement is carried out by methods known in the art (or 15 by obvious modifications of these methods): for example, see W. J. Michaely, EP 369,803.



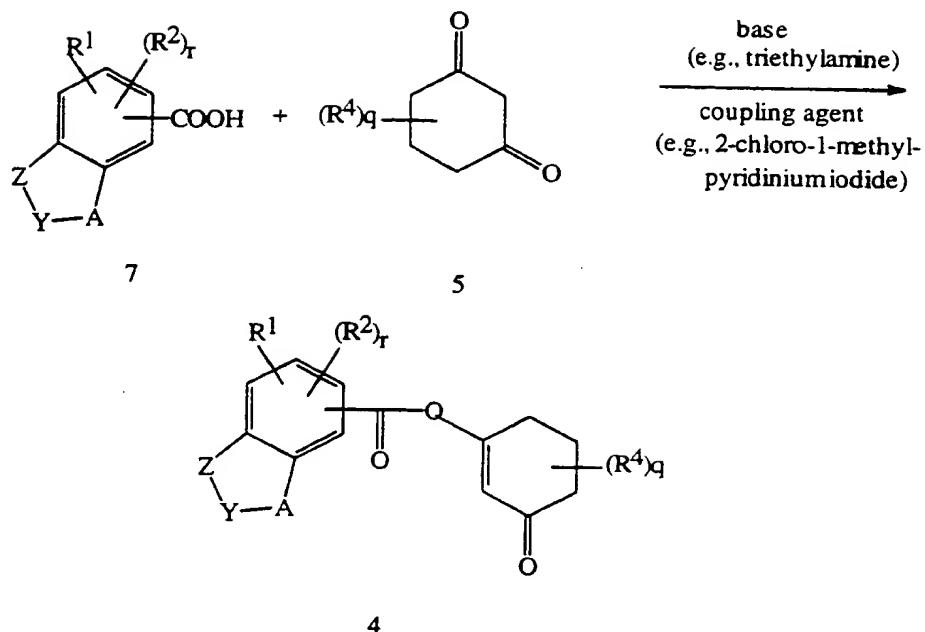
5 Enol esters of Formula 4 can be prepared by reacting a dione of Formula 5 with an acid chloride of Formula 6 in the presence of a slight molar excess of a base such as triethylamine in an inert organic solvent such acetonitrile, methylene chloride or toluene at temperatures between 0 °C and 110 °C (Scheme 6). This type of coupling is known in the art: for example, see W. J. Michaely, EP 369 803

Scheme 6



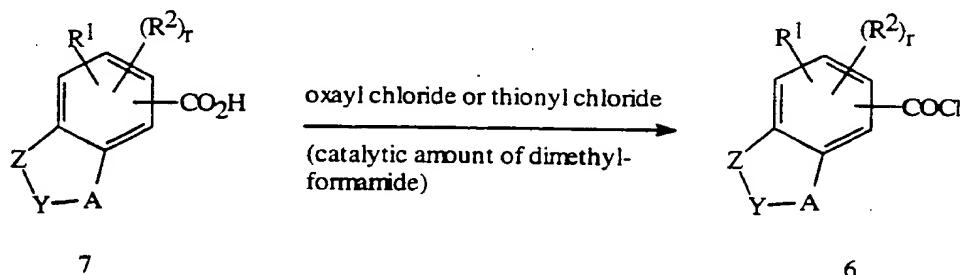
Enol esters of Formula 4 can also be prepared by reacting a dione of Formula 5 with an acid of Formula 7 in the presence of a coupling agent such as 2-chloro-1-methylpyridinium iodide and a slight excess of base such as triethylamine in an inert organic solvent such as acetonitrile, methylene chloride or toluene at temperatures between 0 °C and 110 °C (Scheme 6A). This type of coupling is known in the art: for example, see T. Mukaiyama et al., *Chem. Lett.* (1975), 1045-1048

Scheme 6A



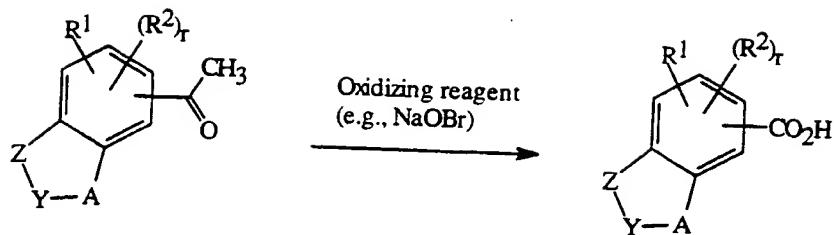
The acid chlorides of Formula 6 can be prepared by reacting an acid of Formula 7 with a halogenating reagent (e.g., oxalyl chloride or thionyl chloride) and a catalytic amount of dimethylformamide (Scheme 7). This chlorination is well known in the art: for example, see W. J. Michaely, EP 369,803.

Scheme 7



10 Scheme 8 illustrates the preparation of acids of Formula 7 whereby a ketone of
 Formula 8 is reacted with an oxidizing reagent such as NaOCl, NaOBr, NaOI or NaNO₂.
 The oxidation is carried out by methods known in the art (or by obvious modifications of
 these methods): for example, see T. F. Braish, et al., *Org. Prep. Proced. Int.*, (1991), 23,
 655-658 and J. A. Skorcz, et al., *Heterocycl. Chem.*, (1973), 10, 249.

Scheme 8



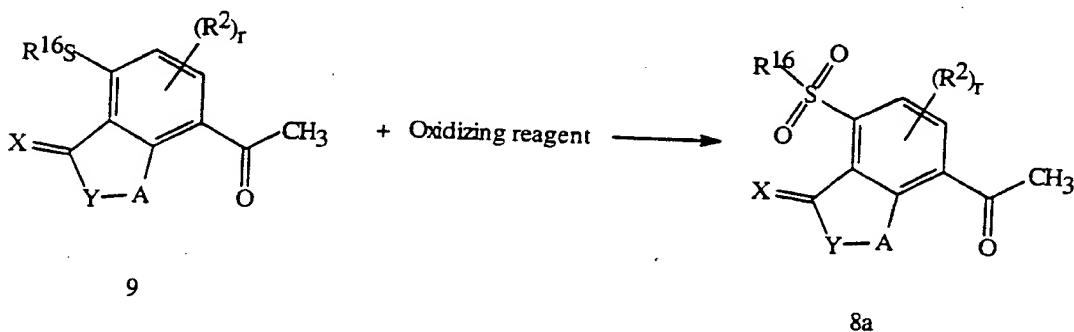
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7

($R^{16}=NR^{10}R^{11}$, C_1-C_6 alkyl, C_1-C_6 haloalkyl, C_3-C_6 alkenyl, C_3-C_6 haloalkenyl, C_3-C_6 alkynyl, C_3-C_6 haloalkynyl or C_3-C_6 cycloalkyl; or phenyl optionally substituted)

5 Scheme 9 illustrates the preparation of sulfones of Formula 8a whereby a sulfide of
 Formula 9 is reacted with an oxidizing reagent such as peroxyacetic acid,
m-chloroperoxybenzoic acid, peroxytrifluoroacetic acid, potassium peroxymonosulfate
 or hydrogen peroxide. The oxidation is carried out by methods known in the art (or by
 10 obvious modifications of these methods): for example, see S. Patai, et al., *The
 Chemistry of Sulphones and Sulphoxides*, John Wiley & Sons, 1988; pp 205-213,
 235-253. For some sulfides of Formula 9 containing a functional group not compatible
 with the reaction conditions, the functional group may be protected before the oxidation
 and then be deprotected after the oxidation. The protection and deprotection procedures
 are well known in the literature: for example, see T. W. Greene, et. al., *Protective
 15 Groups in Organic Synthesis* (Second Edition), John Wiley & Sons, Inc., J. E. McMurry
 and T. Hoz, *J. Org. Chem.*, (1975), 40, 3797 and references cited therein

Scheme 9

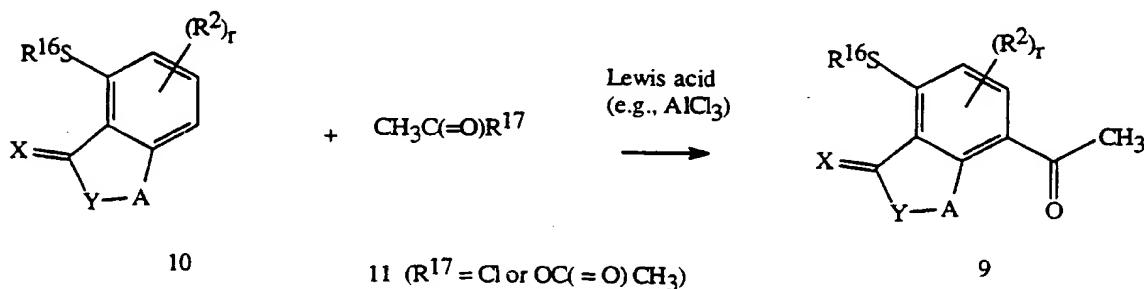


20 $(R^{16}=NR^{10}R^{11}, C_1-C_6 \text{ alkyl}, C_1-C_6 \text{ haloalkyl}, C_3-C_6 \text{ alkenyl}, C_3-C_6 \text{ haloalkenyl}, C_3-C_6$
 $\text{alkynyl}, C_3-C_6 \text{ haloalkynyl or } C_3-C_6 \text{ cycloalkyl; or phenyl optionally substituted})$

Scheme 10 illustrates the preparation of ketones of Formula 9 whereby a sulfide of Formula 10 is reacted with an acylating reagent 11 such as acetyl chloride or acetic

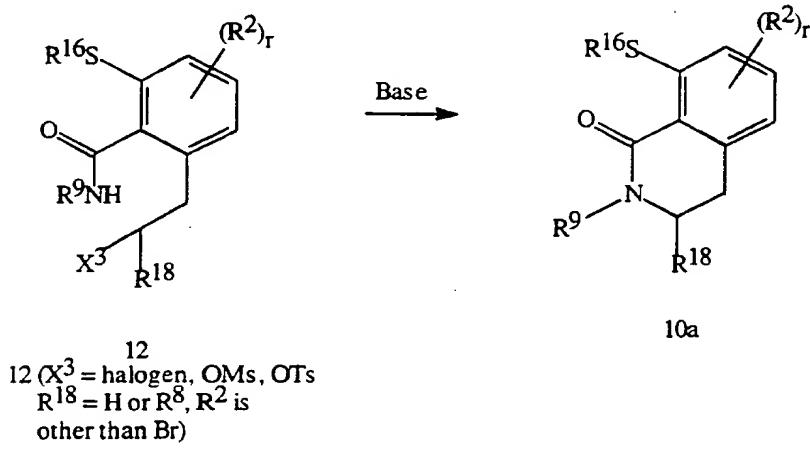
anhydride in the presence of a Lewis acid such as aluminum chloride in a solvent such as carbon disulfide, methylene chloride or 1,2-dichloroethane. This conversion is carried out using methods well known in the art: for example, see R. A. Cutler, *J. Amer. Chem. Soc.*, (1952), 74, 5475.

5

Scheme 10

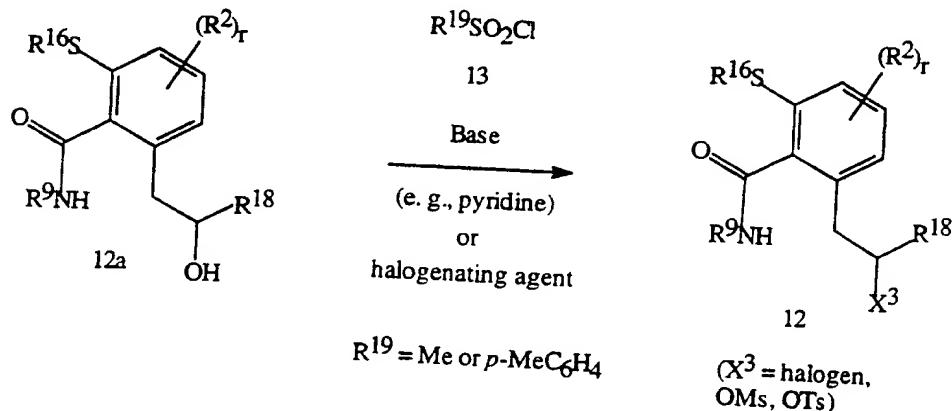
The lactam of Formula 10a ($\text{X} = \text{O}$, $\text{Y} = \text{NR}^9$, $\text{A} = -(\text{CH}_2)_m-$, and $m = 2$) can be prepared by treating an amide of Formula 12 (Scheme 11) with a base such as potassium 10 t -butoxide or sodium hydride in a solvent such as benzene, dimethylformamide or THF. This conversion is carried out using methods known in the art (or obvious modifications of these methods): for example, see R. N. Misra, et al., *Bioorg. Med. Chem. Lett.*, (1991), 1, 295-298.

15

Scheme 11

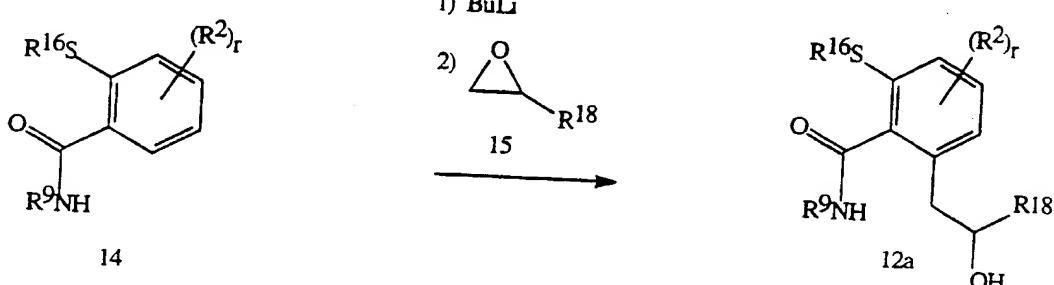
The compounds of Formula 12 (Scheme 12) can be prepared from compounds of Formula 12a ($\text{X}^3 = \text{OH}$) by converting the alcohol to an appropriate leaving group such as a halogen, a mesylate or tosylate. For example, the reactions to prepare the mesylate or tosylate are carried with a sulfonyl chloride of Formula 13 in the presence of a base such as pyridine, sodium hydride or triethylamine in a solvent such as pyridine or 20

5 methylene chloride at temperatures between 0 °C and room temperature. This conversion is carried out using methods well known in the literature (or obvious modifications of these methods): for example, see R. N. Misra, et al., *Bioorg. Med. Chem. Lett.*, (1991), 1, 295-298, *Helv. Chim. Acta*, (1947), 30, 1454 and L. F. Fieser and M. Fieser, *Reagents for Organic Synthesis*, Vol. 1, Wiley, New York, (1967), 1179.

Scheme 12

10 Compounds of Formula 12a (Scheme 13) can be prepared from an amide of Formula 14 by treatment with an excess of a base such as *n*-butyllithium and an electrophile such as an epoxide of Formula 15 in a solvent such as THF. This conversion is carried out using methods known in the literature (or obvious modifications of these methods): for example, see R. N. Misra, et al., *Bioorg. Med. Chem. Lett.*, (1991), 1, 295-298 and B. H. Bhide, et al., *Chem. and Ind.*, (1975), 519.

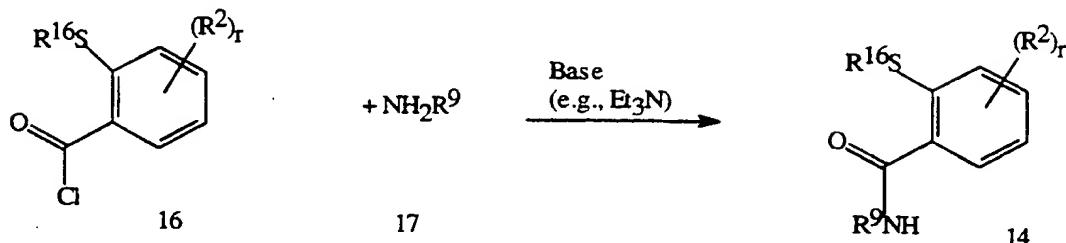
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Scheme 13

20 Compounds of Formula 14 (Scheme 14) can be prepared from an acid chloride of Formula 16 and an amine of Formula 17 in the presence of a base such as triethylamine or excess NH_2R^9 in a solvent such as chloroform. This conversion is carried out using

methods well known in the literature (or obvious modifications of these methods): for example, see A. D. Wolf, EP 196,786.

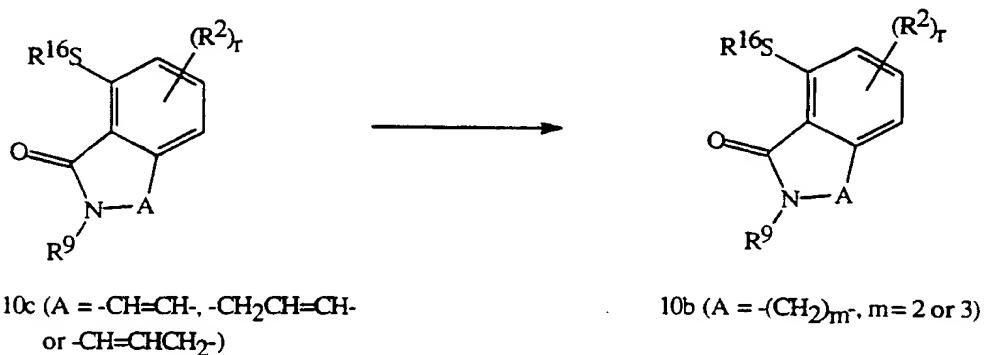
Scheme 14



5

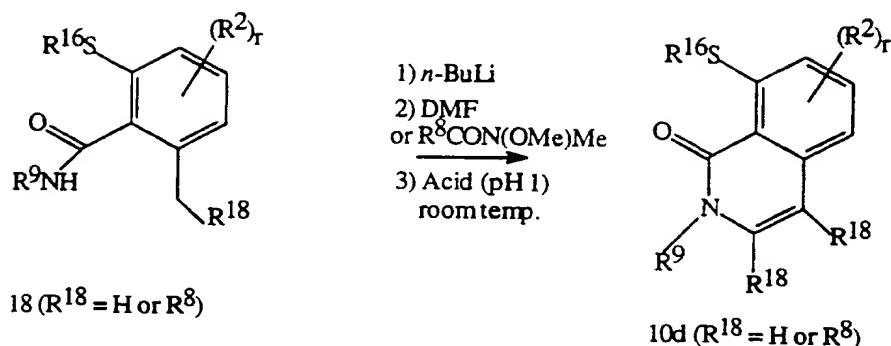
Scheme 15 illustrates the preparation of compounds of Formula 10b (X = O, Y = NR⁹) whereby an olefin of Formula 10c is reacted with a reducing reagent such as hydrogen at 345 kPa (50 psi) in the presence of a catalyst such as palladium on carbon in a solvent such as ethanol. The reduction is carried out by methods well known in the art (or by obvious modifications of these methods): for example, R. D. Clark, et al., *J. Med. Chem.*, (1993), 36, 2645-57 and C. Y. Cheng, *J. Heterocyclic. Chem.*, (1995), 32, 73.

Scheme 15



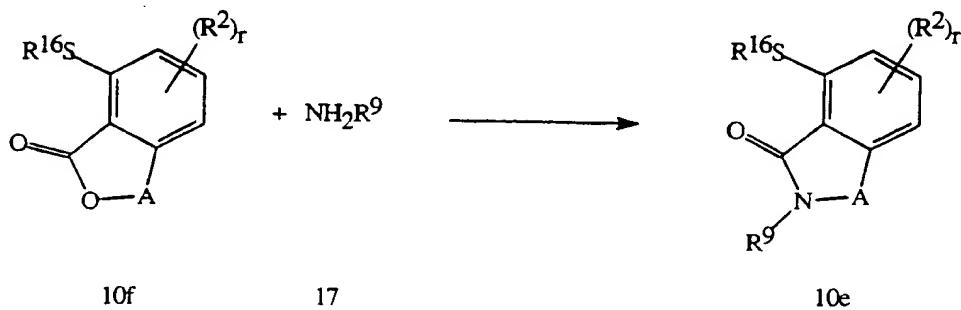
15 Scheme 16 illustrates the preparation of compounds of Formula 10d (X = O, Y = NR⁹) whereby an amide of Formula 18 is treated with an alkylolithium such as n-butyllithium in a solvent such as THF. The resulting dianion is treated with an electrophile such as DMF or an amide to give compounds of Formula 10d. The reaction is carried out by methods well known in the art (or by obvious modifications of these methods): for example, see R. D. Clark, et al., *J. Med. Chem.*, (1993), 36, 2645-57.

Scheme 16



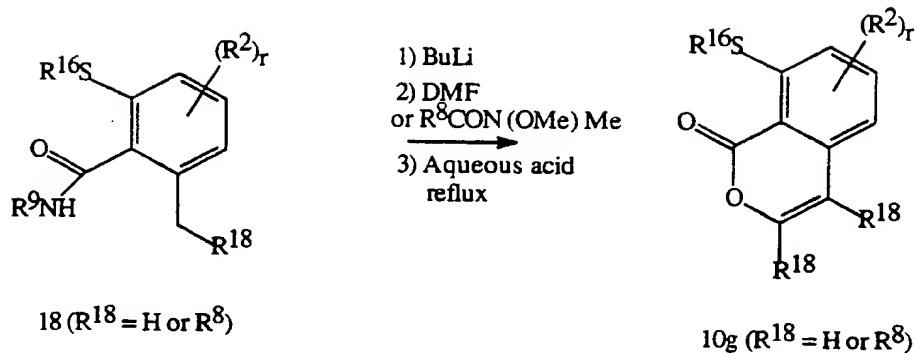
Olefins of Formula 10e ($X = O$, $Y = NR^9$, $A = -CH=CH-$, $-CH_2CH=CH-$ or $-CH=CHCH_2-$) can also be prepared from the corresponding lactones 10f ($Y = O$) with a substituted amine of Formula 17 (Scheme 17). The reaction is carried out by methods well known in the art (or by obvious modifications of these methods): for example, see R. Singh, et. al., *J. Indian Chem. Soc.*, (1991), 68, 276-80, M. Somei, *Chem. Pharm. Bull.*, (1981), 29, 249, and N. Gilman, *Synth. Commun.*, (1982), 12, 373-80.

Scheme 17

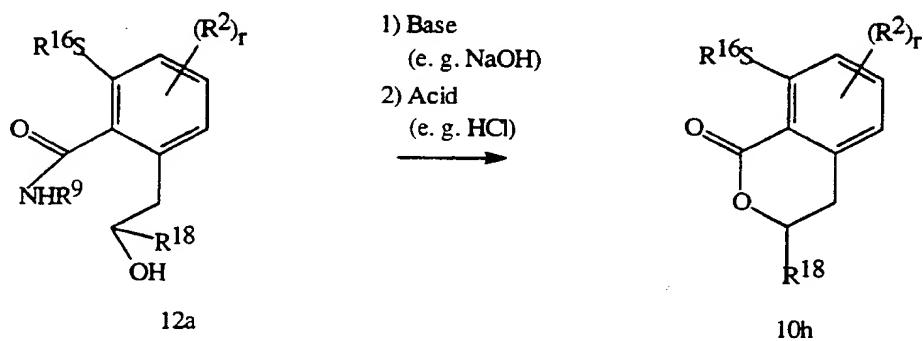


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The preparation of lactones of Formula 10g ($X = O$, $Y = O$) (Scheme 18) is carried out by methods well known in the art (or by obvious modifications of these methods): for example, see R. M. Hauser, *J. Org. Chem.*, (1988), 53, 4676-4681.

Scheme 18

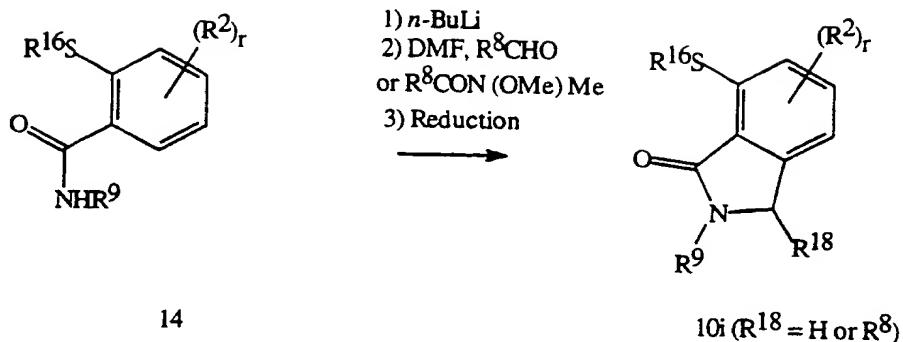
The preparation of compounds of Formula 10h ($X = O$, $Y = O$, $A = -(CH_2)_m-$, $m = 2$) is carried out by methods well known in the art (or by obvious modifications of these methods): for example, R. J. Pasteris, EP 166,516, A. D. Wolf, EP 196,786 and F. M. Hauser, *J. Org. Chem.*, (1988), 53, 4676-4681.

Scheme 19

10 The preparation of compounds of Formula 10i ($X = O$, $Y = NR^9$, $A = -(CH_2)_m-$, $m = 1$) is carried out by methods known in the art (or by obvious modifications of these methods): for example, see J. Epszajn, et al., *Tetrahedron*, (1993), 49, 929-938 and R. J. Pasteris, EP 107,979 and EP 166,516.

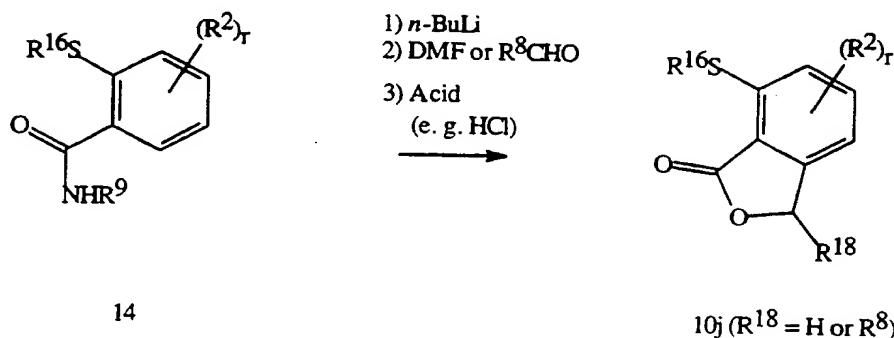
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Scheme 20



5 The preparation of compounds of Formula 10j ($X = O$, $Y = O$, $A = -(CH_2)_m-$,
m = 1) is carried out by methods known in the art (or by obvious modifications of these
methods): for example, see R. Mali, et al., *J. Chem. Res., Synop.*, (1993), 5, 184-185 and
B. H. Bhide, *Tetrahedron*, (1971), 27, 6171.

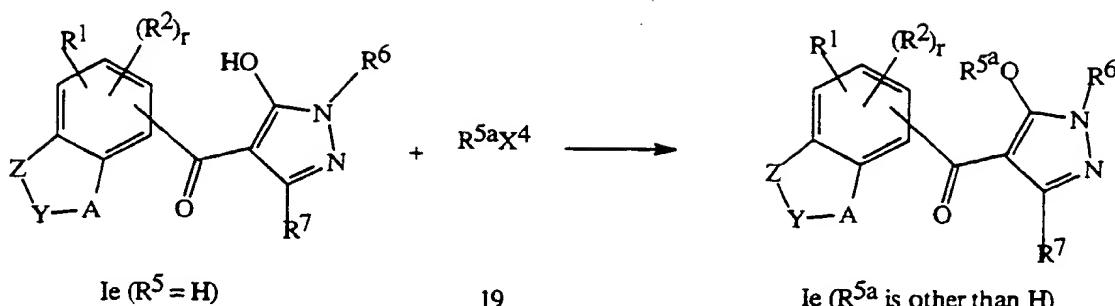
Scheme 21



10 Scheme 22 illustrates the preparation of compounds of Formula Ie ($R^5 = R^{5a}$ and
 R^{5a} is the same as R^5 as described in the Summary of the Invention excluding H)
whereby a compound of Formula Ie ($R^5 = H$) is reacted with a reagent of Formula 19 in
the presence of a base wherein X^4 is chlorine, bromine, fluorine, OTf or OAc and R^{5a} is
as previously defined. This coupling is carried out by methods known in the art (or by
obvious modification of these methods): for example, see K. Nakamura, et al.,
WO 95/04054.

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Scheme 22

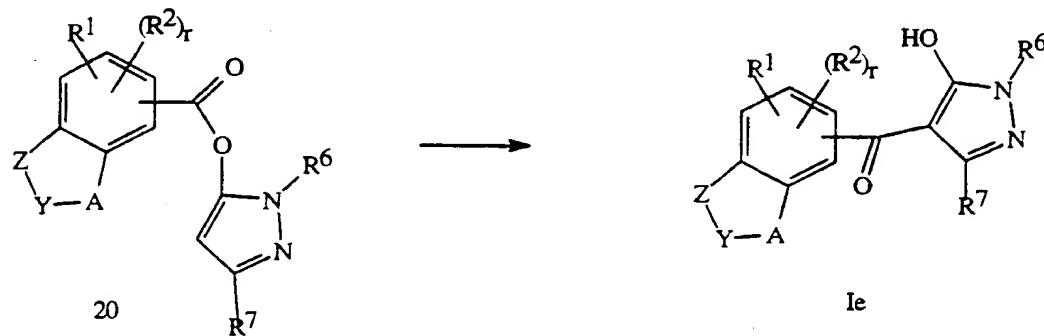


wherein

R^{5a} is the same as R^5 as described in the Summary of the Invention excluding H

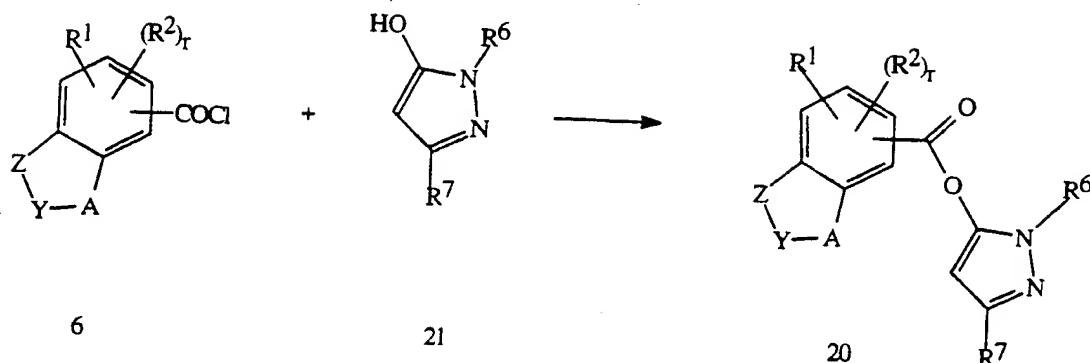
5 Scheme 23 illustrates the preparation of compounds of Formula Ie ($R^5 = H$) whereby an ester of Formula 20 is reacted with a base such as triethylamine in the presence of a catalytic amount of a cyanide source (e.g., acetone cyanohydrin or potassium cyanide). This rearrangement is carried out by methods known in the art (or by obvious modification of these methods): for example, see W. J. Michaely,
 10 EP 369,803.

Scheme 23

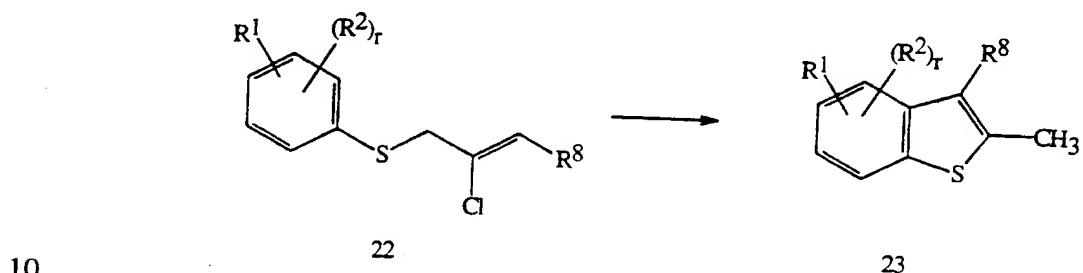


15 An ester of Formula 20 can be prepared by reacting a hydroxypyrazole of
Formula 21 with an acid chloride of Formula 6 in the presence of a slight molar excess of
a base such as triethylamine in an inert organic solvent such as acetonitrile, methylene
chloride or toluene at temperatures between 0 °C and 110 °C (Scheme 24). This type of
coupling is carried out by methods known in the art (or by obvious modification of these
methods): for example, see W. J. Michaely, EP 369,803.

22

Scheme 24

5 Scheme 25 illustrates the synthesis of compounds of the Formula 23 ($\text{R}^8 = \text{C}_1\text{-C}_6$ alkyl) wherein a thioether of the Formula 22 is heated either neat or in the presence of a high boiling solvent such as dimethylaniline at temperature from 150 °C to 200 °C to provide the benzothiophenes 23 (Scheme 25). For a representative example see, W. K. Anderson et al., *J. Chem. Soc. Perkin Transactions I* (1986), 1-4.

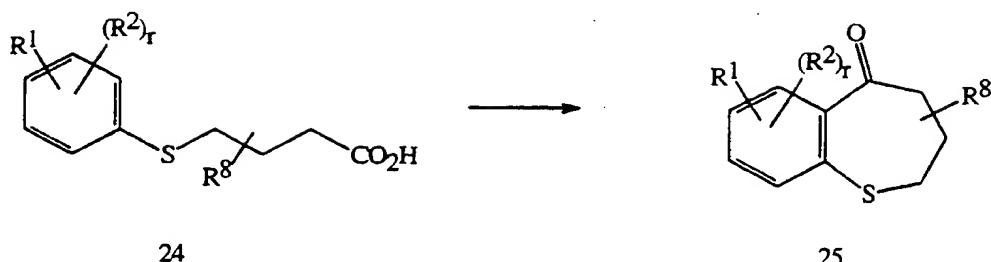
Scheme 25

10

Compounds of the Formula 25 which can serve as intermediates for the synthesis of compounds of the present invention can readily be prepared by acid catalyzed cyclization of an appropriately substituted carboxylic acid of the Formula 24 (Scheme 26). Acid catalysts that have been used to promote this reaction are sulfuric acid, hydrochloric acid, trifluoroacetic acid and polyphosphoric acid. For a general review see, B. Iddon and R. M. Scrowston, *Advances in Heterocyclic Chemistry*, Vol. 1, Academic Press, New York (1970), 177.

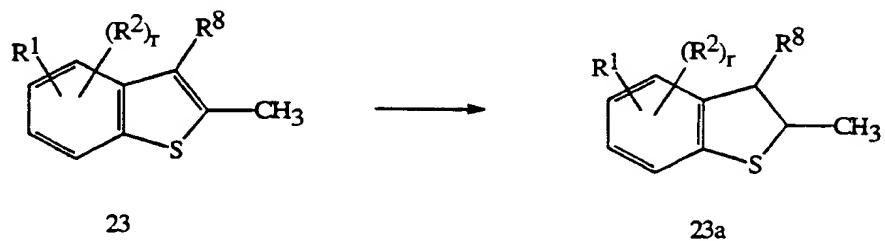
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Scheme 26



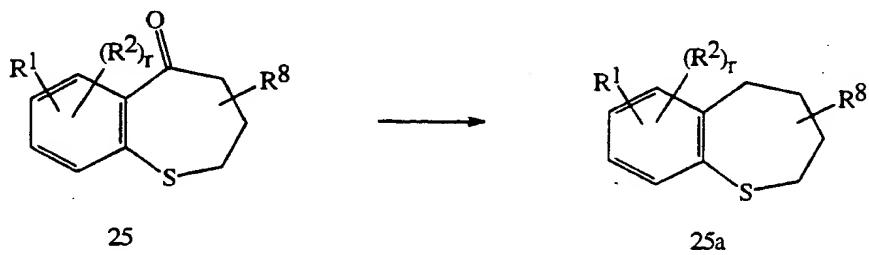
10 The preparation of compounds of the Formula 23a can be accomplished by treatment of compounds of the Formula 23 with triethylsilane in trifluoroacetic acid (Scheme 27). The reaction is best carried out at temperatures between 25 °C and 72 °C. For an example of this transformation see, E. N. Karaulova et al., *Zur Russ. Fiz-Chim.*, (1960), 30, 3292.

Scheme 27



15 Compounds of the Formula 25a can readily be prepared by treatment of compounds of the Formula 25 with triethylsilane in refluxing trifluoroacetic acid (Scheme 28). For a representative example, see, C. T. West et al., *J. Org. Chem.*, (1963), 38, 2675-2681.

Scheme 28



20 Compounds of Formula 26 (A = -(CH₂)_m-, Y = -CH₂-) can be regioselectively brominated *para* to the thioether functionality giving structures of Formula 27 (Scheme 29). Typical conditions employed are the treatment of compounds of Formula 26 with one equivalent to a slight excess of bromine in an inert solvent such as

dichloromethane or chloroform at temperatures from 20 °C up to the boiling point of the solvent. For a representative example see K. Nakamura et al., WO 95/04054.

Scheme 29

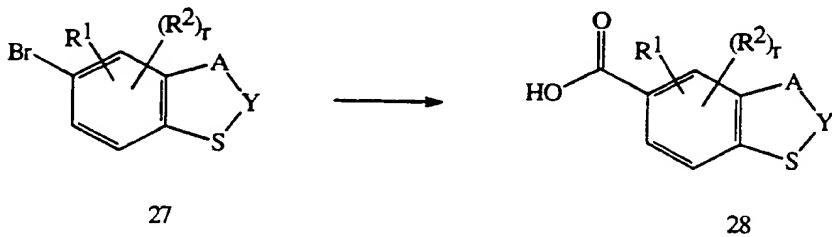


5

10

Scheme 30 illustrates the preparation of carboxylic acids of the Formula 28 ($A = -(CH_2)_m-$, $Y = -CH_2-$) via halogen metal exchange followed by quenching of the resulting anion with carbon dioxide. This general method is carried out by the addition of *n*-butyl lithium to a solution of the compound of the Formula 27 in THF or diethyl ether at temperatures from 25 °C to -70 °C. Carbon dioxide is introduced to produce the resulting acid. This classical reaction is known to one skilled in the art. For a typical procedure see, R. L. Danheiser et al., *J. Am. Chem. Soc.*, (1986), 108, 806-810.

Scheme 30



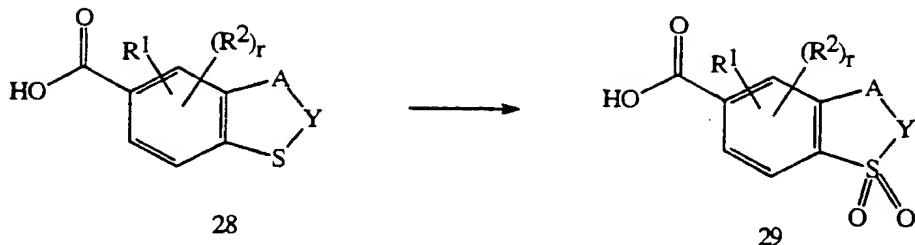
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Compounds of the Formula 29 ($A = -(CH_2)_m-$, $Y = -CH_2-$) (Scheme 31) can readily be prepared by oxidation of compounds of the Formula 28 using any one of a number of oxidants. Typical reagents used for this transformation are hydrogen peroxide, peroxyacetic acid, *m*-chloroperoxybenzoic acid and potassium peroxymonosulfate. The oxidations can be carried out by methods known in the art or obvious modifications. For a general review see, S. Patai et al., *The Chemistry of Sulphones and Sulfoxides*, John Wiley & Sons, 1988, pp. 205-213.

25

Scheme 31



It is recognized that some reagents and reaction conditions described above for preparing compounds of Formula I may not be compatible with certain functionalities present in the intermediates. In these instances, the incorporation of protection/deprotection sequences or functional group interconversions into the synthesis will aid in obtaining the desired products. The use and choice of the protecting groups will be apparent to one skilled in chemical synthesis (see, for example, Greene, T. W.; Wuts, P. G. M. *Protective Groups in Organic Synthesis*, 2nd ed.; Wiley: New York, 1991). One skilled in the art will recognize that, in some cases, after the introduction of a given reagent as it is depicted in any individual scheme, it may be necessary to perform additional routine synthetic steps not described in detail to complete the synthesis of compounds of Formula I. One skilled in the art will also recognize that it may be necessary to perform a combination of the steps illustrated in the above schemes in an order other than that implied by the particular sequence presented to prepare the compounds of Formula I.

One skilled in the art will also recognize that compounds of Formula I and the intermediates described herein can be subjected to various electrophilic, nucleophilic, radical, organometallic, oxidation, and reduction reactions to add substituents or modify existing substituents.

Without further elaboration, it is believed that one skilled in the art using the preceding description can utilize the present invention to its fullest extent. The following Examples are, therefore, to be construed as merely illustrative, and not limiting of the disclosure in any way whatsoever. Percentages are by weight except for chromatographic solvent mixtures or where otherwise indicated. Parts and percentages

¹H NMR spectra are reported in ppm downfield from tetramethylsilane unless otherwise indicated.

¹H NMR spectra are reported in ppm downfield from tetramethylsilane; s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, dd = doublet of doublets, br s = broad singlet.

EXAMPLE 1Step A: Preparation of 2-(ethylthio)benzoic acid

73.5 g (1.84 mol) of sodium hydroxide was dissolved in 750 mL of ethanol. To this solution at 20 °C, 135 g (0.87 mol) of thiosalicylic acid and an additional 600 mL of ethanol was added. After stirring at room temperature for 1 h, the reaction mixture was cooled to 0 °C and 77 mL (0.97 mol) of ethyl iodide was added dropwise. The reaction mixture was then heated under reflux for 1 h, cooled to 10 °C and 1 N HCl added until the mixture was pH 2. The resulting precipitate was collected by filtration and washed several times with water. The solid was dried to give 148 g of the title compound of Step A. ^1H NMR (CDCl_3) δ 1.40 (t,3H), 3.00 (q,2H), 7.20 (t,1H), 7.38 (d,1H), 7.50 (t,1H), 8.15 (d,1H).

Step B: Preparation of *N*-(1,1-dimethylethyl)-2-(ethylthio)benzamide

296.4 g (1.63 mol) of the title compound of Step A, 300 mL (4.07 mol) of thionyl chloride and 600 mL of methylene chloride were heated at reflux for 4 h. After standing at room temperature overnight, an additional 25 mL of thionyl chloride was added and the reaction refluxed an additional 3 h. The reaction was concentrated under reduced pressure, chloroform was added, and the mixture was again concentrated to give 316 g of the acid chloride.

A solution of the acid chloride in 550 mL of chloroform was added dropwise to a solution of 377 mL (3.58 mol) of *t*-butyl amine in 550 mL of chloroform at 0 °C. After the addition was complete, the reaction was heated at 40 °C and then allowed to stand at room temperature overnight. The reaction mixture was poured into water and extracted twice with methylene chloride. The combined organic extracts were washed twice with 1 N HCl, dried (MgSO_4) and concentrated. The crude oil was triturated with hexane to give 284 g of the title compound of Step B as a white solid (a sample prepared in a separate experiment provided material melting at 126-129 °C). An additional 44.6 g was obtained from the filtrate. ^1H NMR (CDCl_3) δ 1.29 (t,3H), 1.48 (s,9H), 2.92 (q,2H), 6.52 (br s, 1H), 7.21-7.40 (m,3H), 7.62 (dd,1H).

Step C: Preparation of *N*-(1,1-dimethylethyl)-2-(ethylthio)-6-(2-hydroxyethyl)benzamide

20.0 g (84.4 mmol) of the title compound of Step B was dissolved in 250 mL of dry THF and cooled to -45 °C. *n*-Butyl lithium (116 mL of a 1.6 M solution in hexanes, 186 mmol) was added dropwise to this mixture at -45 °C. The reaction was allowed to warm to 0 °C and kept at this temperature for 30 min. Ethylene oxide was then added rapidly at 0 °C and the reaction was kept below room temperature. After 1 h, saturated ammonium chloride was added and the reaction mixture was extracted twice with ether. The combined organic extracts were dried (Na_2SO_4) and concentrated. The crude oil was triturated with *n*-butyl chloride to give 9.94 g of the title compound of Step C as a

white solid melting at 113-117 °C. ^1H NMR ($\text{Me}_2\text{SO}-d_6$) δ 1.17 (t,3H), 1.32 (s,9H), 2.67 (t,2H), 2.87 (q,2H) 3.55-3.59 (m,2H), 4.62 (t,1H), 7.00-7.21 (m,3H), 7.84 (br s,1H).

5 **Step D:** Preparation of *N*-(1,1-dimethylethyl)-2-(ethylthio)-6-[2-[(methylsulfonyl)oxy]ethyl]benzamide

To a mixture of 16.67 g (59.32 mmol) of the title compound of Step C in 245 mL of pyridine at 0 °C was added dropwise 14 mL (178 mmol) of mesyl chloride at 0 °C. After 1 h at 0 °C, the reaction mixture was poured into ice water and the precipitate collected by filtration. The solid was washed with water and dried to give 15.14 g of the title compound of Step D (a sample prepared in a separate experiment provided material melting at 111-113 °C). ^1H NMR ($\text{Me}_2\text{SO}-d_6$) δ 1.20 (t,3H), 1.36 (s,9H), 2.93 (m,5H), 3.11 (s,3H), 4.38 (t,2H), 7.17 (dd,1H), 7.30 (m,2H), 8.00 (br s,1H).

10 **Step E:** Preparation of 2-(1,1-dimethylethyl)-8-(ethylthio)-3,4-dihydro-1(2H)-isoquinolinone

15 To a mixture of 5.67 g (50.61 mmol) of potassium *t*-butoxide in 100 mL of dimethylformamide at 0 °C was added a solution of 15.14 g (42.17 mmol) of the title compound of Step D in 100 mL dimethylformamide at 0 °C. The reaction was allowed to warm to room temperature over 1 h and an additional 150 mL of dimethylformamide and 1 g of potassium *t*-butoxide added. After an additional 30 min, the reaction mixture was poured onto ice and 10% HCl was added to adjust the pH to 2. The reaction mixture was extracted three times with ethyl acetate. The combined organic phases were washed three times with water, then saturated aqueous NaCl, dried (MgSO_4) and concentrated to give 8.6 g of the title compound of Step E as an amber oil. ^1H NMR (CDCl_3) δ 1.40 (t,3H), 1.55 (s,9H), 2.88 (m,4H), 3.50 (m,2H), 6.85 (d,1H), 7.18 (d,1H), 7.23 (m,2H).

20 **Step F:** Preparation of 5-acetyl-2-(1,1-dimethylethyl)-8-(ethylthio)-3,4-dihydro-1(2H)-isoquinolinone

25 To a solution of 2.0 g (7.6 mmol) of the title compound of Step E and 32 mL of methylene chloride was added 1.0 g (7.5 mmol) of aluminum chloride. The reaction mixture was heated under reflux for 1 h and cooled to room temperature. A solution of 1.2 g (9.12 mmol) of aluminum chloride and 0.72 g (9.12 mmol) of acetyl chloride in 20 mL of methylene chloride was added and the reaction mixture was refluxed an additional 2 h. The reaction mixture was cooled and 20 mL of 1 N HCl was added dropwise. The phases were separated and the aqueous phase was extracted two more times with methylene chloride. The combined organic phases were dried (MgSO_4) and concentrated to give 2.3 g of an oil. The residue was flash chromatographed on silica gel with ethyl acetate/hexane to give 1.04 g of the title compound of Step F as a white solid (a sample prepared in a separate experiment provided material melting at 109-110 °C).

¹H NMR (Me₂SO-*d*₆) δ 1.25 (t,3H), 1.45 (s,9H), 2.55 (s,3H), 2.89 (q,2H), 3.00 (t,2H), 3.40 (t,2H), 7.33 (d,1H), 7.86 (d,1H).

Step G: Preparation of 5-acetyl-2-(1,1-dimethylethyl)-8-(ethylsulfonyl)-3,4-dihydro-1(2H)-isoquinolinone

5 To a solution of 2.06 g (3.35 mmol) of Oxone® in 8 mL of water was added a solution of 0.41 g (1.34 mmol) of the title compound of Step F in 3 mL of acetone. The reaction mixture was stirred at room temperature for 1.5 h and then diluted with water and ethyl acetate. The phases were separated and the aqueous phase was extracted again with ethyl acetate. The combined organic phases were dried (MgSO₄) and concentrated to give 0.5 g of the title compound of Step G as a solid (a sample prepared in a separate experiment provided material melting at 139-142 °C). ¹H NMR (Me₂SO-*d*₆) δ 1.18 (t,3H), 1.47 (s,9H), 2.62 (s,3H), 3.00(t,2H), 3.48 (t,2H), 3.85 (q,2H), 7.97 (d,1H,J=8.26 Hz), 8.08 (d,1H,J=8.26 Hz).

10 **Step H:** Preparation of 2-(1,1-dimethylethyl)-8-(ethylsulfonyl)-1,2,3,4-tetrahydro-1-oxo-5-isoquinolinecarboxylic acid

15 To a 5 °C solution of 0.54 g (13.5 mmol) of sodium hydroxide in 1.25 mL of water was added 0.24 mL (4.65 mmol) of bromine and the reaction mixture was stirred until a clear yellow solution was obtained. To this solution was added 0.5 g (1.48 mmol) of the title compound of Step G dissolved in 1 mL of 1,4-dioxane and the reaction mixture was stirred at room temperature for 3 h. The reaction mixture was diluted with water and adjusted to pH 2 with concentrated HCl. It was extracted three times with ethyl acetate and the combined organic extracts were dried (MgSO₄) and concentrated to give 0.53 g of the title compound of Step H as an amber oil. ¹H NMR (Me₂SO-*d*₆) δ 1.18 (t,3H), 1.48 (s,9H), 3.20 (t,2H), 3.51 (t,2H), 3.85 (q,2H), 7.95(d,1H,J=8.26 Hz), 8.06 (d,1H,J=8.26 Hz).

20 **Step I:** Preparation of (1-ethyl-1*H*-pyrazol-5-yl) 2-(1,1-dimethylethyl)-8-(ethylsulfonyl)-1,2,3,4-tetrahydro-1-oxo-5-isoquinolinecarboxylate

25 0.5 g (1.45 mmol) of title compound of Step H and 14 mL of thionyl chloride were combined and heated under reflux for 4 h. The reaction mixture was allowed to cool and was then concentrated. The residue was dissolved in methylene chloride and re-concentrated. The residue was dissolved in 6 mL of chloroform and 0.2 g (1.79 mmol) of 1-ethyl-5-hydroxy-1*H*-pyrazole was added followed by 0.18 g (1.78 mmol) of triethylamine. The reaction mixture was heated at reflux for 1 h and then allowed to stir at room temperature overnight. The reaction mixture was poured into ice and 1 N HCl and extracted three times with methylene chloride. The combined organic extracts were dried (MgSO₄) and concentrated to give 0.5 g of an oil. The residue was flash chromatographed on silica gel with ethyl acetate to give 90 mg of the title compound of Step I as a solid (a sample prepared in a separate experiment provided

material melting at 158-161 °C with apparent decomposition). ^1H NMR ($\text{Me}_2\text{SO}-d_6$) δ 1.20 (t,3H), 1.32 (t,3H), 1.49 (s,9H), 3.25 (m,2H), 3.56 (m,2H), 3.87 (q,2H) 4.09 (q,2H), 6.24 (d,1H), 7.47 (d,1H), 8.09 (d,1H), 8.38 (d,1H).

5 **Step J: Preparation of 2-(1,1-dimethylethyl)-5-[(1-ethyl-5-hydroxy-1*H*-pyrazol-4-yl)carbonyl]-8-(ethylsulfonyl)-3,4-dihydro-1(2*H*)-isoquinolinone**

0.28 g (0.65 mmol) of the title compound of Step I, 3.4 mL of dry methylene chloride, 0.16 mL (1.15 mmol) of triethylamine and one drop of acetone cyanohydrin were combined and stirred at room temperature over the weekend. The reaction mixture was diluted with ethyl acetate and 1 N HCl. The organic phase was then extracted three times with saturated aqueous sodium bicarbonate. The basic aqueous phase was adjusted to pH 2 and extracted four times with methylene chloride. The combined methylene chloride extracts were dried (MgSO_4) and concentrated to give 0.35 g. Trituration with ether/hexane gave 0.15 g of the title compound of Step J, a compound of the invention, as a yellow solid melting at 164-167 °C. ^1H NMR ($\text{Me}_2\text{SO}-d_6$) δ 1.20 (t,3H), 1.27 (t,3H), 1.47 (s,9H), 2.82 (t,2H), 3.50 (t,2H), 3.87 (q,2H), 3.92 (q,2H), 7.48 (s,1H), 7.69 (d,1H), 7.97 (d,1H).

EXAMPLE 2

Step A: Preparation of 1-[(2-chloro-2-propenyl)thio]-2,5-dimethylbenzene

To a suspension of potassium carbonate 50.0 g (0.362 mol) in 600 mL of DMF at room temperature was added 50.0 g (0.362 mol) of 2,5-dimethylthiophenol dropwise. The temperature was allowed to rise to 29 °C with continued stirring for an additional 1 h. 40.1 g (0.362 mol) of 2,3-dichloropropene was added dropwise at room temperature and the reaction was allowed to stir overnight. The crude reaction mixture was poured into excess ice/water and the resulting solution was extracted twice with ethyl acetate. The combined organic phase was dried (MgSO_4) and concentrated to give a gold oil 76.1 g of the title compound of Step A which was used in the next step without further purification. ^1H NMR (CDCl_3) δ 2.30 (s,3H), 2.40 (s,3H), 3.64 (s,2H), 5.22 (d,2H), 6.95 (d,1H), 7.08 (d,1H), 7.13 (s,1H).

Step B: Preparation of 2,4,7-trimethylbenzo[*b*]thiophene

30 To 230 mL of dimethylaniline at reflux was added dropwise a solution of 50.0 g (0.236 mol) of the title compound of Step A and 200 mL of dimethylaniline. The solution was heated overnight at reflux and then allowed to come to room temperature. The crude reaction mixture was diluted with excess ether and washed with 1N HCl until dimethylaniline could no longer be detected. The ether layer was dried over MgSO_4 , filtered and concentrated to yield 38.1 g of the title compound of Step B as a brown oil. The compound was used without further purification in the next reaction. ^1H NMR (CDCl_3) δ 2.30 (s,3H), 2.55 (s,3H), 2.61 (s,3H), 6.95 (d,1H), 7.04 (d, 1H), 7.10 (s,1H).

Step C: Preparation of 2,3-dihydro-2,4,7-trimethylbenzo[b]thiophene

A solution of 38.0 g (0.215 mol) of the title compound of step B, 98.0 mL (0.429 mol) of triethylsilane in 280 mL of trifluoroacetic acid was heated overnight at reflux. The crude reaction mixture was concentrated, diluted with excess ether, and 5 washed with saturated sodium bicarbonate until an aqueous test extraction was neutral. The ether phase was dried over $MgSO_4$, filtered and concentrated to yield an orange oil. Chromatography on silica gel with hexane provided 20.4 g of the title compound of Step C as a pale yellow oil. 1H NMR ($CDCl_3$) δ 1.48 (d,3H), 2.20 (s,6H), 2.90 (dd,1H), 3.38(dd,1H), 3.95-4.09 (m,1H), 6.78 (d,1H), 6.83 (d,1H).

10 Step D: Preparation of 5-bromo-2,3-dihydro-2,4,7-trimethylbenzo[b]thiophene

A solution of 10.3 g (58.0 mmol) of the title compound of Step C in 120 mL of dichloromethane was treated at room temperature with 9.3 g (58.0 mmol) of bromine dropwise. The solution was stirred an additional 3 h, diluted with excess ethyl acetate, washed with excess saturated sodium bisulfite solution and dried over $MgSO_4$. Filtration 15 followed by concentration provided the crude product as a yellow oil. Chromatography on silica gel in hexanes provide 10.6 g of the title compound of Step D as a clear oil. 1H NMR ($CDCl_3$) δ 1.46 (d,3H), 2.16 (s,3H), 2.29 (s,3H), 2.95 (dd,1H), 3.40 (dd,1H), 3.93-3.99 (m,1H), 7.15 (s,1H).

20 Step E: Preparation of 2,3-dihydro-2,4,7-trimethylbenzo[b]thiophene-5-carboxylic acid

To a solution of 15.1 g (58.7 mmol) of the title compound of Step D in THF at -70 °C was added dropwise a solution of *n*-butyl lithium (24.7 mL of a 2.5 M solution in hexanes, 61.6 mmol). During the addition, the temperature was maintained below -60 °C. The reaction mixture was stirred an additional 30 min at -70 °C and then excess 25 carbon dioxide gas was passed into the solution (15 min). The reaction mixture was allowed to slowly warm to room temperature and stir overnight. The reaction mixture was diluted with excess water, acidified with concentrated HCl to pH 2, and extracted with ethyl acetate several times. The combined organic phase was dried over $MgSO_4$, filtered and concentrated to provide the crude acid as a green solid. The crude product 30 was suspended in hexanes, collected by filtration, and air dried to yield 8.5 g of the title compound of Step E as a green solid. 1H NMR ($CDCl_3$) δ 1.48(d,3H), 2.23(s,3H), 2.51(s,3H), 3.01(dd,1H), 3.47(dd,1H), 3.98-4.03(m,1H), 7.71(s,1H).

Step F: Preparation of 2,3-dihydro-2,4,7-trimethylbenzo[b]thiophene-5-carboxylic acid 1,1-dioxide

35 To a solution of 38.8 g (56.0 mmol) of Oxone® in 250 mL of water at room temperature was added dropwise a solution of 5.0 g (23.0 mmol) of the title compound of Step E in 50 mL of acetone. To the resulting solution was added portionwise 12.0 g (143 mmol) of sodium bicarbonate. The solution was stirred an additional 1.5 h at room

temperature. To the solution was added 1N HCl to bring the pH to 3. The solution was extracted with ethyl acetate and the combined organic phase was washed with saturated sodium bisulfite solution, dried over $MgSO_4$, filtered and concentrated to provide the title compound of Step F as a white solid melting at 186-189 °C. 1H NMR ($CDCl_3$)

5 δ 1.56 (d,3H), 2.52 (s,3H), 2.65 (s,3H), 2.82 (dd,1H), 3.40-3.61(m,2H), 7.83 (s,1H).

Step G: Preparation of 1-ethyl-1-*H*-pyrazol-5-yl 2,3-dihydro-2,4,7-trimethylbenzo[*b*]thiophene-5-carboxylate 1,1-dioxide

To a solution of 1.0 g (3.94 mmol) of the title compound of Step F in 35 mL of dichloromethane at room temperature was added 0.55 mL (6.30 mmol) of oxalyl

10 chloride and a catalytic amount of dimethylformamide. The resulting solution was heated to reflux for 3 h and then stirred at ambient temperature overnight. The reaction mixture was concentrated *in vacuo*. The crude reaction mass was dissolved in 20 mL of dichloromethane and treated at room temperature successively with 0.89 mL

(6.30 mmol) of triethylamine followed by 0.46 g (4.11 mmol) of 1-ethyl-5-hydroxy-1*H*-

15 pyrazole. The reaction mixture was stirred at room temperature overnight. The reaction mixture was diluted with excess ethyl acetate, washed with water and dried over $MgSO_4$. Filtration followed by concentration afforded the crude product which was chromatographed on silica gel (elution with 1:1 ethyl acetate:hexanes) to afford 0.89 g of the title compound of Step G as a white solid. 1H NMR ($CDCl_3$) δ 1.45 (t,3H), 1.58

20 (d,3H), 2.54 (s,3H), 2.69 (s,3H), 2.85 (dd,1H), 3.47-3.59 (m,2H), 4.10 (q,2H), 6.24 (d,1H), 7.50 (d,1H), 7.86 (s,1H).

Step H: Preparation of (2,3-dihydro-2,4,7-trimethylbenzo[*b*]thiophene-5-yl)(1-ethyl-5-hydroxy-1*H*-pyrazol-4-yl)methanone 5,5-dioxide

To a solution of 0.89 g (2.56 mmol) of the title compound of Step G in 15 mL of acetonitrile at room temperature was added 4 drops of acetone cyanohydrin followed by 0.57 mL (4.09 mmol) of triethylamine. The solution was stirred at room temperature overnight, then diluted with excess water, acidified with 1N HCl to pH 3-5 and extracted with ethyl acetate. The organic phase was dried over $MgSO_4$, filtered and concentrated.

25 The crude product was triturated with a 1:1 mixture of *n*-butyl chloride:hexanes to yield the title compound of Step H, a compound of the invention, as a white solid melting at 152-157 °C. 1H NMR ($CDCl_3$) δ 1.46 (t,3H), 1.57 (d,3H), 2.29 (s,3H), 2.66 (s,3H), 2.80 (dd,1H), 3.44 (dd,1H), 3.50-3.61 (m,1H), 4.08 (q,2H), 7.28 (s,1H), 7.35 (s,1H).

EXAMPLE 3

Step A: Preparation of methyl 4-[(2-ethoxy-2-oxoethyl)thio]-3-nitrobenzoate

35 0.36 g (9 mmol) of 60% sodium hydride was suspended in anhydrous dimethylformamide and cooled to 0 °C. After the dropwise addition of 0.93 mL (8.5 mmol) of ethyl 2-mercaptoproacetate, the reaction was warmed to room temperature and stirred for an additional 30 minutes. 1.8 g (8.3 mmol) of methyl 4-chloro-3-

nitrobenzoate was added dropwise, keeping the reaction temperature below 10 °C. The reaction mixture was then slowly warmed to room temperature and poured into 150 mL of ice water. The precipitate was stirred vigorously for 20 minutes and then filtered. The solid was dried to give 2.3 g of the title compound of Step A as a yellow solid melting at 74-76 °C. ^1H NMR (CDCl_3) δ 8.88 (d,1H), 8.20 (d,1H), 7.6 (d,1H), 4.23 (q,2H), 3.97 (s,3H), 3.80 (s,2H), 1.28 (t,3H).

5 **Step B:** Preparation of methyl 3,4-dihydro-3-oxo-2H-1,4-benzothiazine-6-carboxylate

10 10.0 g (35 mmol) of the title compound of Step A was dissolved in 160 mL of acetic acid and 20 mL of water was added. The solution was heated to 65 °C and 11.7 g (210 mmol) of iron powder was added in small portions. Vigorous stirring was continued for 10 minutes after the end of the iron addition, after which the reaction was filtered through Celite®. The solids were washed with acetic acid and the combined filtrates concentrated. The crude mixture was partitioned between ethyl acetate and 15 sodium bicarbonate solution. The layers were separated and the organic phase was extracted three times with more ethyl acetate. The combined ethyl acetate layers were washed with sodium bicarbonate solution and saturated aqueous NaCl, dried over magnesium sulfate, and concentrated to yield 7.0 g of the title compound of Step B as a white solid melting at 178-180 °C. ^1H NMR (CDCl_3) δ 8.68 (br s,1H), 7.67 (d,1H), 7.57 (s,1H), 7.38 (d,1H), 3.93 (s,3H), 3.49 (s,2H).

20 **Step C:** Preparation of methyl 4-ethyl-3,4-dihydro-3-oxo-2H-1,4-benzothiazine-6-carboxylate

25 10.0 g (45 mmol) of the title compound of Step B was dissolved in 50 mL of anhydrous dimethylformamide. 6.0 g (54 mmol) of potassium *t*-butoxide was added and the reaction was stirred for 15 minutes. 4.0 mL (50 mmol) of ethyl iodide was added dropwise and the reaction was stirred for 2 h. The reaction mixture was poured into 350 mL of cold water and extracted three times with diethyl ether. The combined ether extracts were washed three times with water, twice with saturated aqueous NaCl, and were then dried over magnesium sulfate and concentrated to a crude oil.

30 Chromatography with ethyl acetate and hexane yielded 3.7 g of the title compound of Step C. ^1H NMR (CDCl_3) δ 7.80 (s,1H), 7.70 (d,1H), 7.42 (d,1H), 4.09 (q,2H), 3.94 (s,3H), 3.41 (s,2H), 1.30 (t,3H).

35 **Step D:** Preparation of methyl 4-ethyl-3,4-dihydro-3-oxo-2H-1,4-benzothiazine-6-carboxylate 1,1-dioxide

To a mixture of 2.0 g (8.0 mmol) of the title compound of Step C in 50 mL of methylene chloride was added 5.0 mL (24 mmol) of 32% peracetic acid dropwise over a period of 20 minutes. The reaction mixture was stirred at room temperature for 48 h, diluted further with methylene chloride, washed once with water, twice with sodium

sulfite solution, and once with sodium bicarbonate solution. The organic phase was dried over magnesium sulfate and concentrated to afford 2.05 g of the title compound of Step D as a yellow solid. ^1H NMR (CDCl_3) δ 8.05 (d,1H), 7.99 (m,2H), 4.26 (s,2H), 4.18 (q,2H), 4.00 (s,3H), 1.37 (t,3H).

5 **Step E:** Preparation of 4-ethyl-3,4-dihydro-3-oxo-2H-1,4-benzothiazine-6-carboxylic acid 1,1-dioxide

To a mixture of 2.05 g (7.2 mmol) of the title compound of Step D in 15 mL of methanol was added dropwise a solution of 1.2 g (29 mmol) of sodium hydroxide in 5 mL of water. The reaction mixture was stirred at room temperature for 1 h, diluted 10 with water, and cooled in an ice/water bath. Slow acidification with 1N HCl to pH 2 yielded a precipitate which was isolated by filtration to give 1.45 g of the title compound of Step E as a white solid. ^1H NMR ($\text{Me}_2\text{SO}-d_6$) δ 13.8 (s,1H), 8.02 (d,1H), 7.96 (d,1H), 7.91 (d,1H), 4.91 (s,2H), 4.11 (q,2H), 1.20 (t,3H).

15 **Step F:** Preparation of 3-oxo-1-cyclohexen-1-yl 4-ethyl-3,4-dihydro-3-oxo-2H-1,4-benzothiazine-6-carboxylate 1,1-dioxide

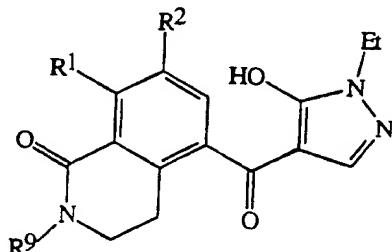
To a mixture of 500 mg (1.86 mmol) of the title compound of Step E and 570 mg (2.23 mmol) of *N*-methyl-2-chloropyridinium iodide in 2 mL of methylene chloride was added 310 μL (2.25 mmol) of triethylamine and the reaction mixture was stirred for 15 minutes. A solution of 212 mg (1.9 mmol) of 1,3-cyclohexanedione and 310 μL 20 (2.25 mmol) of triethylamine in 2 mL of methylene chloride was then added dropwise. After stirring overnight at room temperature, the reaction mixture was concentrated and the crude residue was chromatographed in ethyl acetate and hexane to give 210 mg of the title compound of Step F as a white solid. ^1H NMR (CDCl_3) δ 8.1 (d,1H), 8.02 (s,1H), 8.0 (d,1H), 6.08 (s,1H), 4.28 (s,2H), 4.2 (q,2H), 2.7 (t,2H), 2.5 (t,2H), 2.2 (m,2H), 1.38 (t,3H).

25 **Step G:** Preparation of 4-ethyl-6-[(2-hydroxy-6-oxo-1-cyclohexen-1-yl)carbonyl]-2H-1,4-benzothiazin-3(4H)-one 1,1-dioxide

80 mg (0.22 mmol) of the title compound of Step F, 56 μL (0.40 mmol) of triethylamine, and 1 drop of acetone cyanohydrin were dissolved in 6 mL of dry 30 acetonitrile and stirred for 12 h. A catalytic crystal of potassium cyanide was added to the reaction mixture and stirring was continued for another 24 h. The reaction mixture was then concentrated and the residue was dissolved in water. The aqueous mixture was washed once with diethyl ether, acidified to pH 2 with 1N HCl, and extracted twice with ethyl acetate. The combined ethyl acetate extracts were dried over magnesium sulfate 35 and concentrated to yield 60 mg of the title compound of Step G, a compound of the invention, as an oil which crystallized to a solid melting at 158-165 °C. ^1H NMR (CDCl_3) δ 7.96 (d,1H), 7.37 (s,1H), 7.33 (d,1H), 4.26 (s,2H), 4.12 (q,2H), 2.8 (br s,2H), 2.5 (br s,2H), 2.1 (m,2H), 1.36 (t,3H).

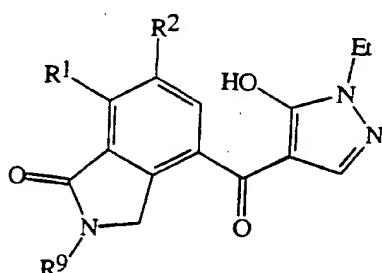
By the procedures described herein together with methods known in the art, the following compounds of Tables 1 to 30 can be prepared. The following abbreviations are used in the Tables which follow: *t* = tertiary, *n* = normal, *i* = iso, Me = methyl, Et = ethyl, Pr = propyl, *i*-Pr = isopropyl, Bu = butyl, Ph = phenyl, OMe = methoxy, 5 OEt = ethoxy, CN = cyano, NO₂ = nitro, CHO = formyl, CO₂Et = ethoxycarbonyl, SO₂Me = methylsulfonyl, SO₂Et = ethylsulfonyl, and SO₂Ph = phenylsulfonyl.

Table 1



<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁹	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁹	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁹
SO ₂ Me	H	H	SO ₂ Et	H	<i>t</i> -Bu	SO ₂ NMe ₂	H	Me
SO ₂ Me	H	Me	SO ₂ Et	H	Me	SO ₂ NMe ₂	H	Et
SO ₂ Me	H	Et	SO ₂ Et	H	CH ₂ CH ₂ OCH ₃	SO ₂ NMe ₂	Me	<i>t</i> -Bu
SO ₂ Me	H	<i>t</i> -Bu	SO ₂ Et	Me	<i>t</i> -Bu	SO ₂ NMe ₂	Me	Me
SO ₂ Me	Me	<i>t</i> -Bu	SO ₂ Et	Me	Me	SO ₂ NMe ₂	Me	Et
SO ₂ Me	Me	Me	SO ₂ Et	Me	Et	SO ₂ NMe ₂	Cl	<i>t</i> -Bu
SO ₂ Me	Me	Et	SO ₂ Et	Cl	<i>t</i> -Bu	SO ₂ NMe ₂	Cl	Et
SO ₂ Me	Cl	H	SO ₂ Et	Cl	Me	SO ₂ Et	H	OMe
SO ₂ Me	Cl	Me	SO ₂ Et	Cl	Et	SO ₂ Et	Me	OMe
SO ₂ Me	Cl	Et	SO ₂ NMe ₂	H	H			

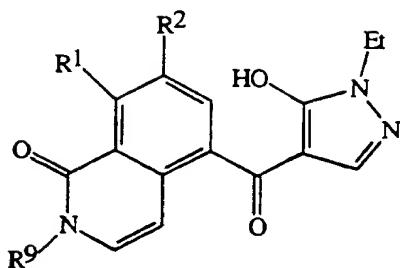
Table 2



<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁹	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁹	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁹
SO ₂ Me	H	Me	SO ₂ Et	H	Me	SO ₂ NMe ₂	Me	<i>t</i> -Bu

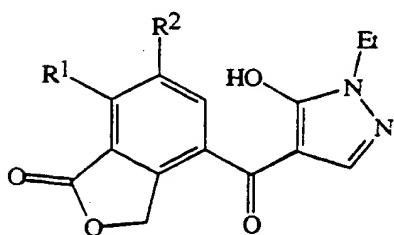
SO ₂ Me	H	Et	SO ₂ Et	H	Et	SO ₂ NMe ₂	Me	Me
SO ₂ Me	H	t-Bu	SO ₂ Et	Me	t-Bu	SO ₂ NMe ₂	Me	Et
SO ₂ Me	Me	H	SO ₂ Et	Me	Me	SO ₂ NMe ₂	Cl	t-Bu
SO ₂ Me	Me	Me	SO ₂ Et	Me	Et	SO ₂ NMe ₂	Cl	Et
SO ₂ Me	Me	Et	SO ₂ Et	Cl	t-Bu	SO ₂ Et	H	OMe
SO ₂ Me	Cl	H	SO ₂ Et	Cl	Me	SO ₂ Et	Me	OMe
SO ₂ Me	Cl	Me	SO ₂ Et	Cl	Et	SO ₂ -n-Pr	H	Me
SO ₂ Me	Cl	Et	SO ₂ NMe ₂	H	t-Bu	SO ₂ -n-Pr	H	t-Bu
SO ₂ Et	H	H	SO ₂ NMe ₂	H	Et			

Table 3



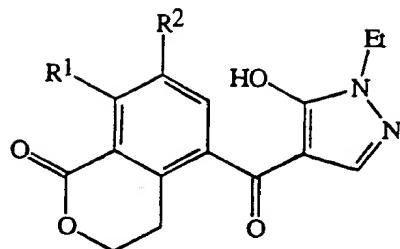
<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁹	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁹	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁹
SO ₂ Me	H	H	SO ₂ Me	Me	Et	SO ₂ Et	Cl	t-Bu
SO ₂ Me	H	Me	SO ₂ Me	Cl	t-Bu	SO ₂ NMe ₂	H	t-Bu
SO ₂ Me	H	Et	SO ₂ Me	Cl	Me	SO ₂ NMe ₂	Me	t-Bu
SO ₂ Me	H	t-Bu	SO ₂ Me	Cl	Et	SO ₂ NMe ₂	Cl	t-Bu
SO ₂ Me	Me	t-Bu	SO ₂ Et	H	t-Bu	SO ₂ Et	H	OMe
SO ₂ Me	Me	Me	SO ₂ Et	Me	t-Bu	SO ₂ Et	Me	OMe

Table 4



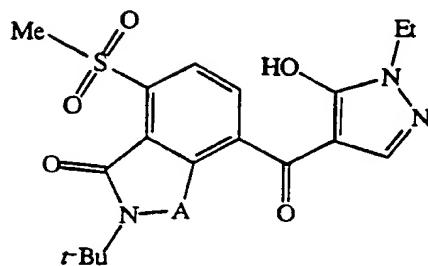
<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²
SO ₂ Me	H	SO ₂ Et	H	SO ₂ NMe ₂	H
SO ₂ Me	Me	SO ₂ Et	Me	SO ₂ NMe ₂	Me

Table 5



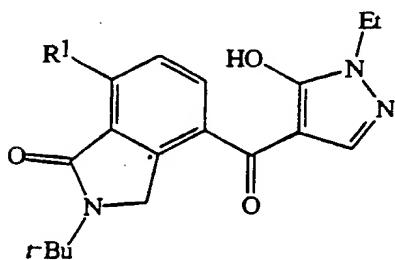
<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²
SO ₂ Me	H	SO ₂ Et	H	SO ₂ Et	Cl	SO ₂ NMe ₂	Me
SO ₂ Me	Me	SO ₂ Et	Me	SO ₂ NMe ₂	H	SO ₂ NMe ₂	Cl
SO ₂ Me	Cl						

Table 6



<u>A</u> -CH ₂ CH ₂ CH ₂ -	<u>A</u> -CH ₂ CH=CH-	<u>A</u> -CH=CHCH ₂ -
--	-------------------------------------	-------------------------------------

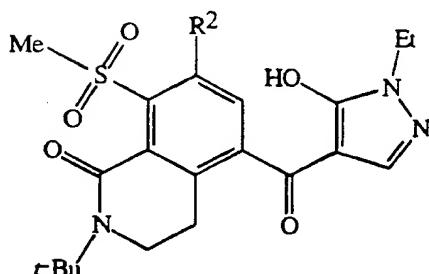
Table 7



<u>R</u> ¹	<u>R</u> ¹	<u>R</u> ¹
SO ₂ NH ₂	SO ₂ NH- <i>n</i> -Pr	SO ₂ N(<i>n</i> -Pr) ₂
SO ₂ NEt ₂	SO ₂ NHCH ₂ CH ₂ Cl	SO ₂ NHCH ₂ CH=C(CH ₃) ₂
SO ₂ NHCH ₂ CF ₃	SO ₂ NHOMe	SO ₂ NHOEt
SO ₂ NHCH ₂ C≡CH	SO ₂ NHCH ₂ C ₆ H ₅	SO ₂ NHC ₆ H ₄ -2-Me
SO ₂ NHC ₆ H ₅	SO ₂ NH ₂ C ₆ H ₄ -3-OMe	SO ₂ NHC ₆ H ₄ -3-OCF ₃

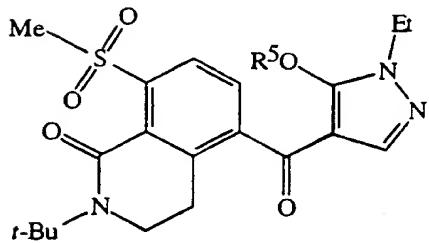
SO ₂ NHC ₆ H ₄ -3-CF ₃	SO ₂ NHC ₆ H ₄ -3-CN	SO ₂ NHC ₆ H ₄ -3-NO ₂
SO ₂ NHC ₆ H ₃ -2,4-diCl	SO ₂ -azetidinyl	SO ₂ -pyrrolidinyl
SO ₂ -piperdinyl	SO ₂ -2,6-dimethylmorpholinyl	SO ₂ -i-Pr
SO ₂ -t-Bu	SO ₂ -n-C ₅ H ₁₁	SO ₂ -n-C ₆ H ₁₃
SO ₂ CH ₂ CH ₂ CF ₃	SO ₂ CH ₂ C≡CH	SO ₂ -cyclopropyl
SO ₂ -cyclohexyl	SO ₂ C ₆ H ₅	SO ₂ C ₆ H ₄ -2-Me
SO ₂ C ₆ H ₄ -3-CF ₃	SO ₂ C ₆ H ₄ -2-OMe	SO ₂ C ₆ H ₄ -3-OCF ₃
SO ₂ C ₆ H ₃ -2,4-diCl	SO ₂ C ₆ H ₄ -3-CN	SO ₂ C ₆ H ₄ -3-NO ₂
SO ₂ NHMe	SO ₂ NHEt	

Table 8



<u>R²</u>	<u>R²</u>	<u>R²</u>	<u>R²</u>
Et	<i>n</i> -Pr	<i>i</i> -Pr	CF ₃
Et	O- <i>n</i> -Pr	OCF ₃	OCH ₂ CF ₃
Br	F	CN	

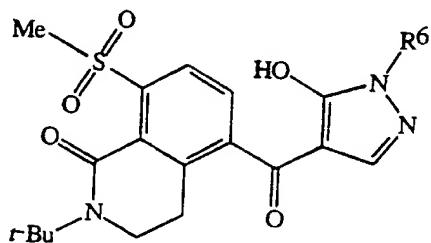
Table 9



<u>R⁵</u>	<u>R⁵</u>	<u>R⁵</u>	<u>R⁵</u>
Me	SO ₂ C ₆ H ₅	CONEt ₂	CO ₂ Me
CF ₃	C(=O)C ₆ H ₄ -3-CN	SO ₂ CF ₃	CONHEt
C(=O)CH ₃	Et	C(=O)C ₆ H ₄ -2-CH ₃	SO ₂ Me

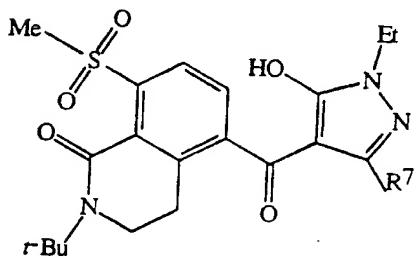
CO ₂ Et	CH ₂ OMe	SO ₂ C ₆ H ₄ -4-CH ₃	C(=O)C ₆ H ₅
CONMe ₂	C(=O)CH ₂ CH ₃	n-Pr	C(=O)C ₆ H ₄ -3-CF ₃
SO ₂ Et	CONHMe	CHO	SO ₂ C ₆ H ₄ -4-CF ₃
SO ₂ -n-Pr			

Table 10



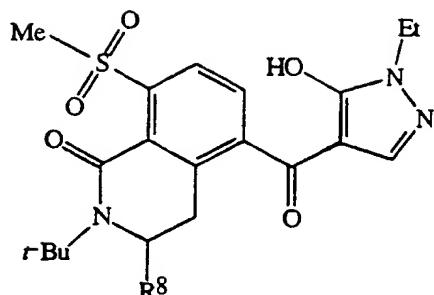
<u>R⁶</u>	<u>R⁶</u>	<u>R⁶</u>
H	Me	n-Pr
CH ₂ CF ₃	CH ₂ CH=CH ₂	CH ₂ C≡CH
C ₆ H ₅	CH ₂ C ₆ H ₅	C ₆ H ₃ -2,4-diCl

Table 11



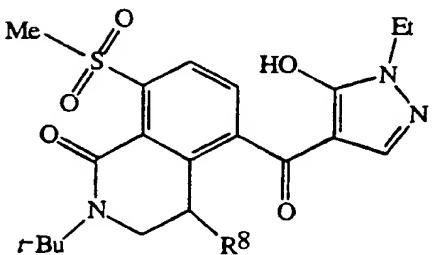
<u>R⁷</u>	<u>R⁷</u>	<u>R⁷</u>
Me	Et	CF ₃
F	n-Pr	CN
NO ₂	Br	

Table 12



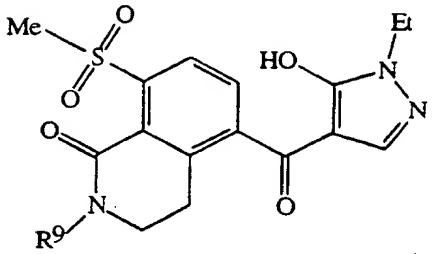
<u>R⁸</u>	<u>R⁸</u>	<u>R⁸</u>	<u>R⁸</u>
Me	Et	n-Pr	t-Bu
CF ₃	OMe	=O	=S

Table 13



<u>R⁸</u>	<u>R⁸</u>	<u>R⁸</u>	<u>R⁸</u>
Me	Et	n-Pr	t-Bu
CF ₃	OMe	=O	=S

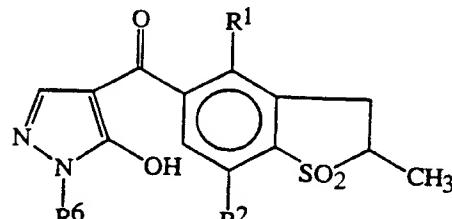
Table 14



<u>R⁹</u>	<u>R⁹</u>	<u>R⁹</u>	<u>R⁹</u>
n-C ₅ H ₁₁	n-C ₆ H ₁₃	cyclopropyl	cyclohexyl
CH ₂ C≡CH	CHO	C(=O)CH ₃	CO ₂ Me
OEt	CONMe ₂	C ₆ H ₅	CH ₂ C ₆ H ₅
CONHMe	C ₆ H ₄ -2-Me	C ₆ H ₄ -3-CF ₃	C ₆ H ₄ -2-OMe

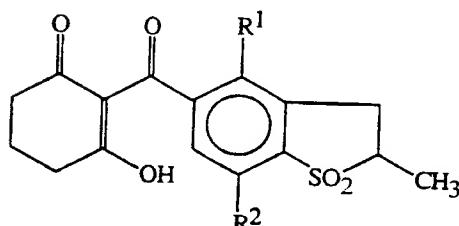
<chem>COc1ccccc1</chem>	<chem>Cc1ccccc1-2,4-diCl</chem>	<chem>Cc1ccccc1-3-CN</chem>	<chem>Cc1ccccc1-3-NO2</chem>
<chem>Cc1ccccc1-3-OCF3</chem>	<chem>CCl2CCl</chem>	<chem>CC=CC2</chem>	<chem>CCOC(=O)c1ccccc1</chem>

Table 15



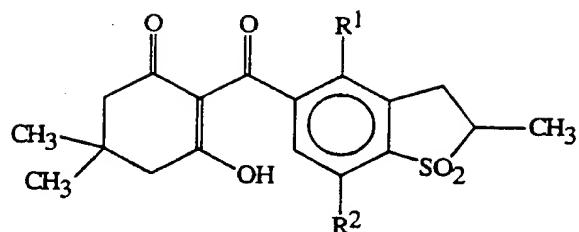
<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁶	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁶	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁶
Cl	Cl	Et	OCH ₃	OCH ₃	Et	CH ₃	CH ₃	Me
CH ₃	Cl	Et	OCH ₂ CH ₃	H	Et	CH ₃	CH ₃	<i>n</i> -propyl
CH ₃	CH ₃	Et	CH ₃	H	Et	CH ₃	CH ₃	<i>t</i> -butyl
CF ₃	H	Et	CH ₃ SO ₂	H	Et	CH ₃	H	Me
<i>n</i> -butyl	H	Et	H	H	Et	Cl	Cl	Me
Cl-CH ₂ CH ₂	H	Et	OCF ₃	H	Et	CH ₃	H	Me
F	F	Et	F	H	Et	CH ₃	CH ₃	Ph
CH ₃	CH ₃	CF ₃	CH ₃	CH ₃	<i>i</i> -propyl			
CH ₃	CH ₃	CF ₂ H						

Table 16



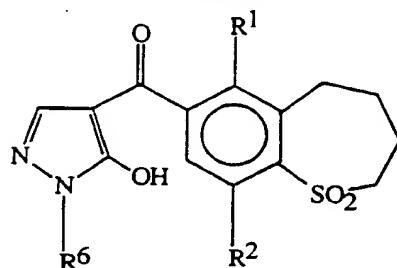
<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²
Cl	H	CH ₃	CH ₃	F	F	OCH ₂ CH ₃	H
H	Cl	CH ₃	H	Et	H	OCH ₂ CH ₃	Cl
OCH ₃	OCH ₃	Cl	Cl	<i>n</i> -propyl	H	H	H

Table 17



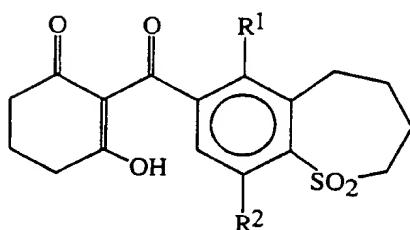
<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²
CH ₃	CH ₃	H	H	Cl	H
Cl	Cl	OCH ₃	OCH ₃	CH ₃	H

Table 18



<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁶	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁶	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁶
Cl	Cl	Et	OCH ₃	OCH ₃	Et	Cl	Cl	CH ₃
CH ₃	Cl	Et	OCH ₂ CH ₃	H	Et	OCH ₃	OCH ₃	CH ₃
CH ₃	CH ₃	Et	CH ₃	H	Et	CH ₃	CH ₃	Ph
CF ₃	H	Et	H	H	Et	CH ₃ SO ₂	H	Et
<i>n</i> -butyl	H	Et	OCF ₃	H	Et	CH ₃ SO ₂	H	CH ₃
CH ₃	CH ₃	CH ₃	CH ₃	CH ₃	<i>i</i> -propyl	H	OCH ₃	CH ₃
F	F	CH ₃	OCH ₃	H	CH ₃	CH ₃	H	Ph
H	CH ₃ SO ₂	Et	CH ₃	CH ₃	<i>t</i> -butyl	NO ₂	H	Et
CH ₃	CH ₃	<i>n</i> -butyl	NO ₂	H	CH ₃			

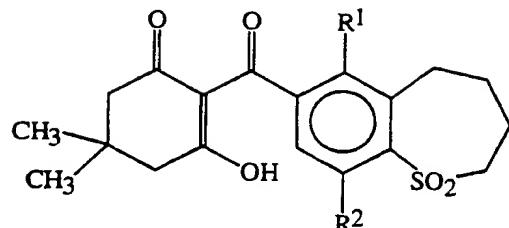
Table 19



<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²
CH ₃	H	OCH ₃	H	H	CH ₃	CH ₃ SO ₂	H

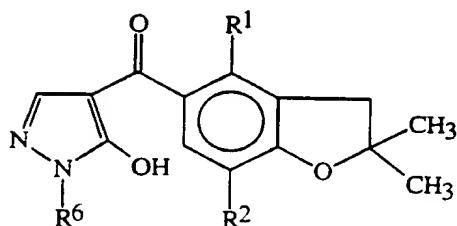
CH ₃	CH ₃	OCH ₃	OCH ₃	CF ₃	H	OEt	H
Cl	H	F	F	NO ₂	H	SO ₂ N(CH ₃) ₂	H
Cl	Cl	F	H	Et	H	ClCH ₂ CH ₂	H
CH ₃ CH ₂ SO ₂	H	CF ₂ H	H	CH ₂ F	H	OCF ₃	H

Table 20



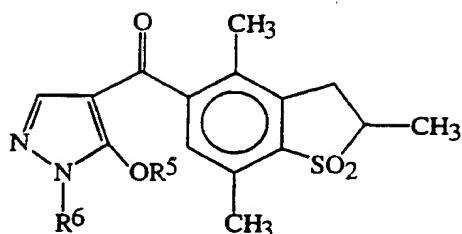
<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ¹	<u>R</u> ²
CH ₃	CH ₃	Et	H	Cl	Cl	OCH ₃	H
CH ₃	H	OCH ₃	OCH ₃	F	H	NO ₂	H
CH ₃	Cl	CH ₃ SO ₂	H	F	F	CF ₃	H
OEt	H	H	H	H	Cl	H	CH ₃

Table 21



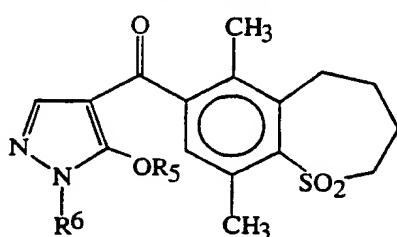
<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁶	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁶	<u>R</u> ¹	<u>R</u> ²	<u>R</u> ⁶
CH ₃	CH ₃	Et	OCH ₃	CH ₃	Et	F	H	Et
Cl	Cl	Et	OCH ₃	H	Et	F	F	CH ₃
CH ₃	CH ₃	CH ₃	OCH ₃	OCH ₃	Et	CH ₃ SO ₂	H	Et
CH ₃	CH ₃	<i>n</i> -propyl	CH ₃	CH ₃	<i>t</i> -butyl	CH ₃	H	Et

Table 22



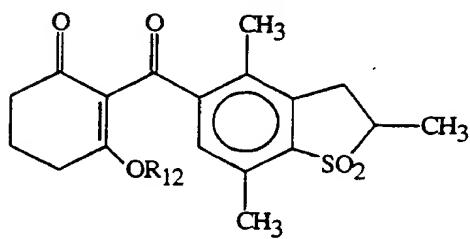
<u>R</u> ⁵	<u>R</u> ⁶	<u>R</u> ⁵	<u>R</u> ⁶	<u>R</u> ⁵	<u>R</u> ⁶	<u>R</u> ⁵	<u>R</u> ⁶
CH ₃	Et	CH ₃ OCH ₂	Et	CH ₃ SO ₂	Et	benzoyl	Et
CH ₂ CH ₃	Et	CH ₃ OCH ₂ CH ₂	Et	CH ₃ CH ₂ SO ₂	Et	PhSO ₂	Et
CH(O)	Et	(Me) ₂ NC(O)	Et	CH ₃ C(O)	Et	CH ₃ OC(O)	Et
CH ₃	CH ₃	CH ₃ SO ₂	CH ₃	benzoyl	CH ₃	PhSO ₂	CH ₃

Table 23



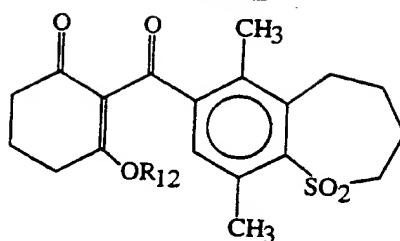
<u>R</u> ⁵	<u>R</u> ⁶	<u>R</u> ⁵	<u>R</u> ⁶	<u>R</u> ⁵	<u>R</u> ⁶
CH ₃	Et	CH ₃ OCH ₂	Et	benzoyl	Me
Et	Et	CH ₃ OCH ₂	Me	benzoyl	Et
CHO	Et	CH ₃ OCH ₂ CH ₂	Et	CH ₃ SO ₂	Me
CH ₃	CH ₃	CH ₃ OCH ₂ CH ₂	Me	CH ₃ SO ₂	Et
PhSO ₂	CH ₃	PhSO ₂	Et	EtSO ₂	Et

Table 24



<u>R</u> ¹²	<u>R</u> ¹²	<u>R</u> ¹²	<u>R</u> ¹²
CH ₃	CH ₃ OCH ₂	CH ₃ SO ₂	CH ₃ OC=O
Et	CH ₃ OCH ₂ CH ₂	EtSO ₂	(CH ₃) ₂ NC=O
n-Pr	CH ₃ C=O	benzoyl	PhSO ₂

Table 25



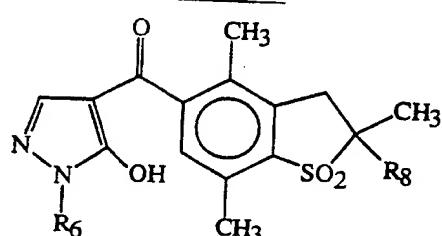
R₁₂
CH₃
Et
t-Butyl
n-propylC=O

R₁₂
CF₃
CH₃OCH₂
CH₃OCH₂CH₂
EtC=O

R₁₂
CH₃SO₂
n-propylSO₂
benzoyl
CHO

R₁₂
PhSO₂
CH₃OC=O
CH₃C=O
FCH₂CH₂

Table 26



R⁶
Et
Et
CH₃

R⁸
CH₃
Et
CH₃

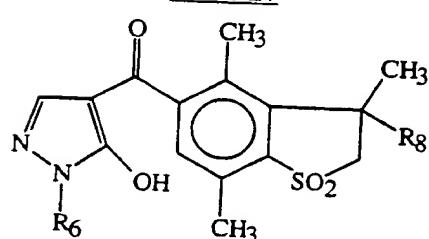
R⁶
Et
Et
CH₃

R⁸
Cl
CF₃
Cl

R⁶
Et
Et
CH₃

R⁸
n-propyl
ClCH₂
CF₃

Table 27



R⁶
Et
Et
Me

R⁸
CH₃
H
H

R⁶
Et
Et
Me

R⁸
Cl
OCH₃
Me

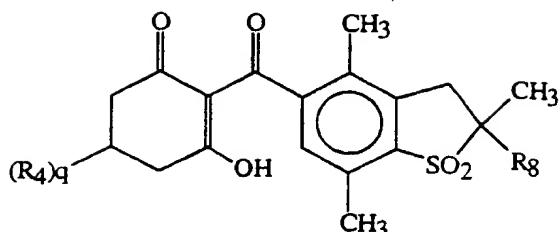
R⁶
Et
Me
n-propyl

R⁸
OCH₃
CH₃

R⁶
t-butyl
t-butyl
n-butyl

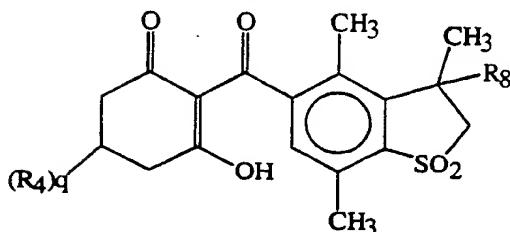
R⁸
H
CH₃
H

Table 28



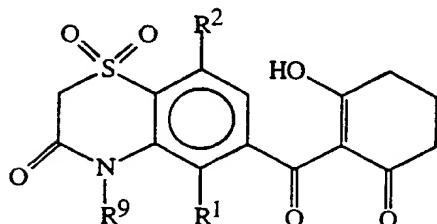
<u>R⁴</u>	<u>q</u>	<u>R⁸</u>									
H	2	CH ₃	H	2	Et	H	2	Cl	H	2	<i>n</i> -propyl
CH ₃	2	CH ₃	CH ₃	2	Et	CH ₃	2	Cl	CH ₃	2	<i>n</i> -propyl

Table 29



<u>R⁴</u>	<u>q</u>	<u>R⁸</u>	<u>R⁴</u>	<u>q</u>	<u>R⁸</u>
H	2	H	H	2	OCH ₃
H	2	CH ₃	CH ₃	2	OCH ₃
CH ₃	2	H	CH ₃	2	OEt
CH ₃	2	CH ₃	H	2	OEt

Table 30



<u>R¹</u>	<u>R²</u>	<u>R⁹</u>
H	H	Me
Me	H	Me
H	Me	Me
Me	Me	Me
H	H	Et
H	H	<i>t</i> -Bu
Cl	Cl	Et

Me	Me	Et
Me	Me	<i>i</i> -Bu

Formulation/Utility

Compounds of this invention will generally be used as a formulation or composition with an agriculturally suitable carrier comprising at least one of a liquid diluent, a solid diluent or a surfactant. The formulation or composition ingredients are selected to be consistent with the physical properties of the active ingredient, mode of application and environmental factors such as soil type, moisture and temperature.

Useful formulations include liquids such as solutions (including emulsifiable concentrates), suspensions, emulsions (including microemulsions and/or suspoemulsions) and the like which optionally can be thickened into gels. Useful formulations further include solids such as dusts, powders, granules, pellets, tablets, films, and the like which can be water-dispersible ("wettable") or water-soluble. Active ingredient can be (micro)encapsulated and further formed into a suspension or solid formulation; alternatively the entire formulation of active ingredient can be encapsulated (or "overcoated"). Encapsulation can control or delay release of the active ingredient.

Sprayable formulations can be extended in suitable media and used at spray volumes from about one to several hundred liters per hectare. High-strength compositions are primarily used as intermediates for further formulation.

The formulations will typically contain effective amounts of active ingredient, diluent and surfactant within the following approximate ranges which add up to 100 percent by weight.

	Weight Percent		
	<u>Active Ingredient</u>	<u>Diluent</u>	<u>Surfactant</u>
Water-Dispersible and Water-soluble Granules, Tablets and Powders.	5-90	0-94	1-15
Suspensions, Emulsions, Solutions (including Emulsifiable Concentrates)	5-50	40-95	0-15
Dusts Granules and Pellets	1-25 0.01-99	70-99 5-99.99	0-5 0-15
High Strength Compositions	90-99	0-10	0-2

Typical solid diluents are described in Watkins, et al., *Handbook of Insecticide Dust Diluents and Carriers*, 2nd Ed., Dorland Books, Caldwell, New Jersey. Typical liquid diluents are described in Marsden, *Solvents Guide*, 2nd Ed., Interscience, New York, 1950. *McCutcheon's Detergents and Emulsifiers Annual*, Allured Publ. Corp.,

Ridgewood, New Jersey, as well as Sisely and Wood, *Encyclopedia of Surface Active Agents*, Chemical Publ. Co., Inc., New York, 1964, list surfactants and recommended uses. All formulations can contain minor amounts of additives to reduce foam, caking, corrosion, microbiological growth and the like, or thickeners to increase viscosity.

5 Surfactants include, for example, polyethoxylated alcohols, polyethoxylated alkylphenols, polyethoxylated sorbitan fatty acid esters, dialkyl sulfosuccinates, alkyl sulfates, alkylbenzene sulfonates, organosilicones, *N,N*-dialkyltaurates, lignin sulfonates, naphthalene sulfonate formaldehyde condensates, polycarboxylates, and polyoxyethylene/polyoxypropylene block copolymers. Solid diluents include, for
10 example, clays such as bentonite, montmorillonite, attapulgite and kaolin, starch, sugar, silica, talc, diatomaceous earth, urea, calcium carbonate, sodium carbonate and bicarbonate, and sodium sulfate. Liquid diluents include, for example, water, *N,N*-dimethylformamide, dimethyl sulfoxide, *N*-alkylpyrrolidone, ethylene glycol, polypropylene glycol, paraffins, alkylbenzenes, alkylnaphthalenes, oils of olive, castor,
15 linseed, tung, sesame, corn, peanut, cotton-seed, soybean, rape-seed and coconut, fatty acid esters, ketones such as cyclohexanone, 2-heptanone, isophorone and 4-hydroxy-4-methyl-2-pentanone, and alcohols such as methanol, cyclohexanol, decanol and tetrahydrofurfuryl alcohol.

20 Solutions, including emulsifiable concentrates, can be prepared by simply mixing the ingredients. Dusts and powders can be prepared by blending and, usually, grinding as in a hammer mill or fluid-energy mill. Suspensions are usually prepared by wet-milling; see, for example, U.S. 3,060,084. Granules and pellets can be prepared by spraying the active material upon preformed granular carriers or by agglomeration techniques. See Browning, "Agglomeration", *Chemical Engineering*, December 4, 1967, pp 147-48,
25 *Perry's Chemical Engineer's Handbook*, 4th Ed., McGraw-Hill, New York, 1963, pages 8-57 and following, and WO 91/13546. Pellets can be prepared as described in U.S. 4,172,714. Water-dispersible and water-soluble granules can be prepared as taught in U.S. 4,144,050, U.S. 3,920,442 and DE 3,246,493. Tablets can be prepared as taught in U.S. 5,180,587, U.S. 5,232,701 and U.S. 5,208,030. Films can be prepared as taught
30 in GB 2,095,558 and U.S. 3,299,566.

For further information regarding the art of formulation, see U.S. 3,235,361, Col. 6, line 16 through Col. 7, line 19 and Examples 10-41; U.S. 3,309,192, Col. 5, line 43 through Col. 7, line 62 and Examples 8, 12, 15, 39, 41, 52, 53, 58, 132, 138-140, 162-164, 166, 167 and 169-182; U.S. 2,891,855, Col. 3, line 66 through Col. 5, line 17
35 and Examples 1-4; Klingman, *Weed Control as a Science*, John Wiley and Sons, Inc., New York, 1961, pp 81-96; and Hance et al., *Weed Control Handbook*, 8th Ed., Blackwell Scientific Publications, Oxford, 1989.

In the following Examples, all percentages are by weight and all formulations are prepared in conventional ways. Compound numbers refer to compounds in Index Tables A-E.

Example A

5 High Strength Concentrate

Compound 20	98.5%
silica aerogel	0.5%
synthetic amorphous fine silica	1.0%.

Example B

10 Wettable Powder

Compound 22	65.0%
dodecylphenol polyethylene glycol ether	2.0%
sodium ligninsulfonate	4.0%
sodium silicoaluminate	6.0%
15 montmorillonite (calcined)	23.0%.

Example C

Granule

Compound 20	10.0%
attapulgite granules (low volatile matter,	
20 0.71/0.30 mm; U.S.S. No. 25-50 sieves)	90.0%.

Example D

Extruded Pellet

Compound 22	25.0%
anhydrous sodium sulfate	10.0%
25 crude calcium ligninsulfonate	5.0%
sodium alkylnaphthalenesulfonate	1.0%
calcium/magnesium bentonite	59.0%.

Test results indicate that the compounds of the present invention are highly active preemergent and postemergent herbicides or plant growth regulants. Many of them have utility for broad-spectrum pre- and/or postemergence weed control in areas where complete control of all vegetation is desired such as around fuel storage tanks, industrial storage areas, parking lots, drive-in theaters, air fields, river banks, irrigation and other waterways, around billboards and highway and railroad structures. Some of the compounds are useful for the control of selected grass and broadleaf weeds with tolerance to important agronomic crops which include but are not limited to alfalfa, barley, cotton, wheat, rape, sugar beets, corn (maize), sorghum, soybeans, rice, oats, peanuts, vegetables, tomato, potato, perennial plantation crops including coffee, cocoa, oil palm, rubber, sugarcane, citrus, grapes, fruit trees, nut trees, banana, plantain,

pineapple, hops, tea and forests such as eucalyptus and conifers (e.g., loblolly pine), and turf species (e.g., Kentucky bluegrass, St. Augustine grass, Kentucky fescue and Bermuda grass). Those skilled in the art will appreciate that not all compounds are equally effective against all weeds. Alternatively, the subject compounds are useful to 5 modify plant growth.

Compounds of this invention can be used alone or in combination with other commercial herbicides, insecticides or fungicides. Compounds of this invention can also be used in combination with commercial herbicide safeners such as benoxacor, dichlormid and furilazole to increase safety to certain crops. A mixture of one or more 10 of the following herbicides with a compound of this invention may be particularly useful for weed control: acetochlor, acifluorfen and its sodium salt, aclonifen, acrolein (2-propenal), alachlor, ametryn, amidosulfuron, amitrole, ammonium sulfamate, anilofos, asulam, atrazine, azimsulfuron, benazolin, benazolin-ethyl, benfluralin, benfuresate, bensulfuron-methyl, bensulide, bentazone, bifenox, bromacil, bromoxynil, bromoxynil 15 octanoate, butachlor, butralin, butylate, chlomethoxyfen, chloramben, chlorbromuron, chloridazon, chlorimuron-ethyl, chlornitrofen, chlorotoluron, chlorpropham, chlorsulfuron, chlorthal-dimethyl, cinmethylin, cinosulfuron, clethodim, clomazone, clopyralid, clopyralid-olamine, cyanazine, cycloate, cyclosulfamuron, 2,4-D and its butotyl, butyl, isoctyl and isopropyl esters and its dimethylammonium, diolamine and 20 trolamine salts, daimuron, dalapon, dalapon-sodium, dazomet, 2,4-DB and its dimethylammonium, potassium and sodium salts, desmedipham, desmetryn, dicamba and its diglycolammonium, dimethylammonium, potassium and sodium salts, dichlobenil, dichlorprop, diclofop-methyl, 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid (AC 263,222), difenzoquat 25 metilsulfate, diflufenican, dimepiperate, dimethenamid, dimethylarsinic acid and its sodium salt, dinitramine, diphenamid, diquat dibromide, dithiopyr, diuron, DNOC, endothal, EPTC, esprocarb, ethalfluralin, ethametsulfuron-methyl, ethofumesate, ethyl α ,2-dichloro-5-[4-(difluoromethyl)-4,5-dihydro-3-methyl-5-oxo-1H-1,2,4-triazol-1-yl]-4-fluorobenzenepropionate (F8426), fenoxaprop-ethyl, fenoxaprop-P-ethyl, fenuron, 30 fenuron-TCA, flamprop-methyl, flamprop-M-isopropyl, flamprop-M-methyl, flazasulfuron, fluazifop-butyl, fluazifop-P-butyl, fluchloralin, flumetsulam, flumiclorac-pentyl, flumioxazin, fluometuron, fluoroglycofen-ethyl, flupoxam, fluridone, flurochloridone, fluroxypyr, fomesafen, fosamine-ammonium, glufosinate, glufosinate-ammonium, glyphosate, glyphosate-isopropylammonium, 35 glyphosate-sesquisodium, glyphosate-trimesium, halosulfuron-methyl, haloxyfop-etyl, haloxyfop-methyl, hexazinone, imazamethabenz-methyl, imazamox (AC 299 263), imazapyr, imazaquin, imazaquin-ammonium, imazethapyr, imazethapyr-ammonium, imazosulfuron, ioxynil, ioxynil octanoate, ioxynil-sodium, isoproturon, isouron, isoxaben,

isoxaflutole (RPA 201772), lactofen, lenacil, linuron, maleic hydrazide, MCPA and its dimethylammonium, potassium and sodium salts, MCPA-isoctyl, mecoprop, mecoprop-P, mefenacet, mefluidide, metam-sodium, methabenzthiazuron, methyl [[2-chloro-4-fluoro-5-[(tetrahydro-3-oxo-1H,3H-[1,3,4]thiadiazolo[3,4-a]pyridazin-1-ylidene)amino]phenyl]thioacetate (KIH 9201), methylarsonic acid and its calcium, monoammonium, monosodium and disodium salts, methyl [[[1-[5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrophenyl]-2-methoxyethylidene]amino]oxy]acetate (AKH-7088), methyl 5-[[[[4,6-dimethyl-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]-1-(2-pyridinyl)-1H-pyrazole-4-carboxylate (NC-330), metobenzuron, metolachlor, metosulam, metoxuron, metribuzin, metsulfuron-methyl, molinate, monolinuron, napropamide, naptalam, neburon, nicosulfuron, norflurazon, oryzalin, oxadiazon, 3-oxetanyl 2-[[[[4,6-dimethyl-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]benzoate (CGA 277476), oxyfluorfen, paraquat dichloride, pebulate, pendimethalin, perfluidone, phenmedipham, picloram, picloram-potassium, pretilachlor, primisulfuron-methyl, prometon, prometryn, propachlor, propanil, propaquizafop, propazine, prophan, propyzamide, prosulfuron, pyrazolynate, pyrazosulfuron-ethyl, pyridate, pyrithiobac, pyrithiobac-sodium, quinclorac, quizalofop-ethyl, quizalofop-P-ethyl, quizalofop-P-tefuryl, rimsulfuron, sethoxydim, siduron, simazine, sulcotrione (ICIA0051), sulfentrazone, sulformeturon-methyl, TCA, TCA-sodium, tebuthiuron, terbacil, terbutylazine, terbutryn, thenylchlor, thiafluamide (BAY 11390), thifensulfuron-methyl, thiobencarb, tralkoxydim, tri-allate, triasulfuron, tribenuron-methyl, triclopyr, triclopyr-butotyl, triclopyr-triethylammonium, tridiphane, trifluralin, triflusulfuron-methyl, and vernolate.

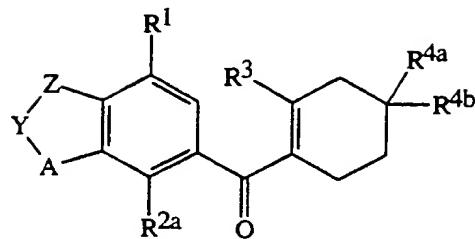
In certain instances, combinations with other herbicides having a similar spectrum of control but a different mode of action will be particularly advantageous for preventing the development of resistant weeds.

Preferred for better control of undesired vegetation (e.g., lower use rate, broader spectrum of weeds controlled, or enhanced crop safety) or for preventing the development of resistant weeds are mixtures of a compound of this invention with a herbicide selected from the group atrazine, chlorimuron-ethyl, cyanazine, glyphosate (and its isopropylammonium, sesquisodium and trimesium salts), imazaquin (and its ammonium salt), imazethapyr (and its ammonium salt), nicosulfuron, primisulfuron-methyl, rimsulfuron and thifensulfuron-methyl. Specifically preferred mixtures (compound numbers refer to compounds in Index Tables A-E) are selected from the group: compound 1 and atrazine; compound 1 and chlorimuron-ethyl; compound 1 and cyanazine; compound 1 and glyphosate; compound 1 and imazaquin; compound 1 and imazethapyr; compound 1 and nicosulfuron; compound 1 and primisulfuron-methyl; compound 1 and rimsulfuron; compound 1 and

thifensulfuron-methyl; compound 20 and atrazine; compound 20 and chlorimuron-ethyl; compound 20 and cyanazine; compound 20 and glyphosate; compound 20 and imazaquin; compound 20 and imazethapyr; compound 20 and nicosulfuron; compound 20 and primisulfuron-methyl; compound 20 and rimsulfuron; compound 20 and
5 thifensulfuron-methyl; compound 21 and atrazine; compound 21 and chlorimuron-ethyl; compound 21 and cyanazine; compound 21 and glyphosate; compound 21 and imazaquin; compound 21 and imazethapyr; compound 21 and nicosulfuron; compound 21 and primisulfuron-methyl; compound 21 and rimsulfuron; compound 21 and thifensulfuron-methyl; compound 22 and atrazine; compound 22 and chlorimuron-ethyl;
10 compound 22 and cyanazine; compound 22 and glyphosate; compound 22 and imazaquin; compound 22 and imazethapyr; compound 22 and nicosulfuron; compound 22 and primisulfuron-methyl; compound 22 and rimsulfuron; compound 22 and thifensulfuron-methyl; compound 41 and atrazine; compound 41 and chlorimuron-ethyl; compound 41 and cyanazine; compound 41 and glyphosate; compound 41 and
15 imazaquin; compound 41 and imazethapyr; compound 41 and nicosulfuron; compound 41 and primisulfuron-methyl; compound 41 and rimsulfuron; and compound 41 and thifensulfuron-methyl.

A herbicidally effective amount of the compounds of this invention is determined by a number of factors. These factors include: formulation selected, method of
20 application, amount and type of vegetation present, growing conditions, etc. In general, a herbicidally effective amount of compounds of this invention is 0.001 to 20 kg/ha with a preferred range of 0.004 to 1.0 kg/ha. One skilled in the art can easily determine the herbicidally effective amount necessary for the desired level of weed control.

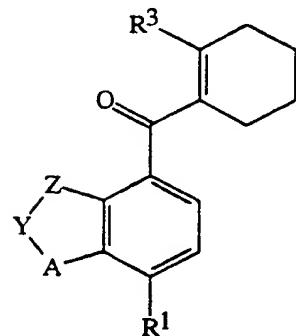
The following Tests demonstrate the control efficacy of the compounds of this
25 invention against specific weeds. The weed control afforded by the compounds is not limited, however, to these species. See Index Tables A-E for compound descriptions. The following abbreviations are used in the Index Tables which follow: *t* = tertiary, *n* = normal, *i* = iso, Me = methyl, Et = ethyl, Pr = propyl, Bu = butyl, Ph = phenyl, OMe = methoxy, MeSO₂ = methylsulfonyl, EtSO₂ = ethylsulfonyl,
30 PhSO₂ = phenylsulfonyl, and PhC(O) = benzoyl. The abbreviation "Ex." stands for "Example" and is followed by a number indicating in which example the compound is prepared.

INDEX TABLE A

wherein R^{2a} is H or R² and
 R^{4a} and R^{4b} are independently H or R⁴

Cmpd No.	A	Y	Z	R ¹	R ^{2a}	R ³	R ^{4a}	R ^{4b}	m.p. (°C)
1 (Ex. 3)	-C(=O)-NEt-	CH ₂	S(O) ₂	H	H	OH	H	H	158-165
2	-CH ₂ -	CHMe	S(O) ₂	Me	Me	OH	H	H	209-214
3	-(CH ₂) ₃ -	CH ₂	S(O) ₂	Me	Me	OH	H	H	160-166
4	-C(=O)-N(i-Bu)-	CH ₂	S(O) ₂	H	H	OH	H	H	oil*
5	-(CH ₂) ₃ -	CH ₂	S(O) ₂	Me	Me	OH	Me	Me	137-138
6	-CH ₂ -NEt-	CH ₂	S(O) ₂	H	H	OH	H	H	158-161
7	-C(=O)-NMe-	CH ₂	S(O) ₂	H	H	OH	H	H	185-195
8	-CH ₂ -NMe-	CH ₂	S(O) ₂	H	H	OH	H	H	143-149
9	-CHMe-	CH ₂	S(O) ₂	Me	Me	OH	Me	Me	156-160
10	-CHMe-	CHMe	S(O) ₂	Me	Me	OH	H	H	170-178
11	-CHMe-	CHMe	S(O) ₂	Me	Me	OH	Me	Me	84-97
12	-(CH ₂) ₂ -CH(OMe)-	CH ₂	S(O) ₂	Me	Me	OH	H	H	82-101
13	-CHMe-	CH ₂	S(O) ₂	Me	Me	OH	H	H	189-193
14	-CH(t-Bu)-	CH ₂	S(O) ₂	Me	Me	OH	H	H	87-92
15	-CH(t-Bu)-	CH ₂	S(O) ₂	Me	Me	OH	Me	Me	175-185
16	-(CH ₂) ₂ -CH(OMe)-	CH ₂	S(O) ₂	Me	Me	OH	Me	Me	78-84

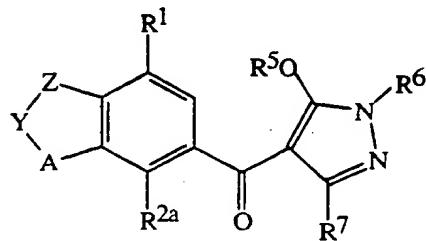
*See Index Table E for ¹H NMR data.

INDEX TABLE B

<u>Cmpd No.</u>	<u>A</u>	<u>Y</u>	<u>Z</u>	<u>R¹</u>	<u>R³</u>	<u>m.p. (°C)</u>
17	-CH ₂ -CMe ₂ -	CH ₂	S(O) ₂	H	OH	foam*
18	-CH ₂ -CMe ₂ -	CH ₂	S(O) ₂	Cl	OH	foam*

*See Index Table E for ¹H NMR data.

5

INDEX TABLE C

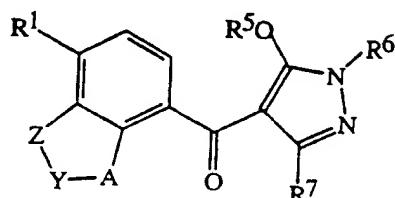
wherein R^{2a} is H or R²

<u>Cmpd No.</u>	<u>A</u>	<u>Y</u>	<u>Z</u>	<u>R¹</u>	<u>R^{2a}</u>	<u>R⁵</u>	<u>R⁶</u>	<u>R⁷</u>	<u>m.p. (°C)</u>
19	-CH ₂ -	CMe ₂	O	Me	Me	H	Et	H	124-129
20 (Ex. 2)	-CH ₂ -	CHMe	S(O) ₂	Me	Me	H	Et	H	152-157
21	-(CH ₂) ₃ -	CH ₂	S(O) ₂	Me	Me	H	Et	H	148-153
22	-CH ₂ -	CHMe	S(O) ₂	Me	Me	H	Me	H	208-209
23	-CH ₂ -	CMe ₂	O	Me	Me	H	Me	H	168-171
24	-C(=O)-NET-	CH ₂	S(O) ₂	H	H	H	Et	H	170-185
25	-CHMe-	CH ₂	S(O) ₂	Me	Me	H	Me	H	226-232
26	-CHMe-	CH ₂	S(O) ₂	Me	Me	H	Et	H	109-124
27	-CHMe-	CHMe	S(O) ₂	Me	Me	H	Et	H	94-104
28	-CHMe-	CHMe	S(O) ₂	Me	Me	H	Me	H	139-147
29	-CHMe-	CH ₂	S(O) ₂	Me	Me	PhSO ₂	Et	H	69-76
30	-CHMe-	CH ₂	S(O) ₂	Me	Me	PhC(O)	Et	H	oil*

31	$-(CH_2)_2-CH(OMe)-$	CH ₂	S(O) ₂	Me	Me	H	Et	H	159-161
32	$-CH(t\text{-}Bu)\text{-}$	CH ₂	S(O) ₂	Me	Me	H	Et	H	191-197
33	$-CHMe\text{-}$	CH ₂	S(O) ₂	Me	Me	MeSO ₂	Et	H	178-180
34	$-CH(t\text{-}Bu)\text{-}$	CH ₂	S(O) ₂	Me	Me	H	Me	H	>200*
35	$-(CH_2)_2-CH(OMe)\text{-}$	CH ₂	S(O) ₂	Me	Me	H	Me	H	53-60

*See Index Table E for ¹H NMR data.

INDEX TABLE D



5

Cmpd No.	A	Y	Z	R ¹	R ⁵	R ⁶	R ⁷	m.p. (°C)
36	$-(CH_2)_2\text{-}$	NMe	C(=O)	EtSO ₂	H	Et	H	195-197
37	$-(CH_2)_2\text{-}$	NMe	C(=O)	MeSO ₂	H	Et	H	213-218
38 ^a	$-CH_2\text{-}$	O	C(=O)	EtSO ₂	H	Et	H	gum*
39	$-CH_2\text{-}$	N(r-Bu)	C(=O)	<i>n</i> -PrSO ₂	H	Et	H	193-199
40	$-CH_2\text{-}$	NMe	C(=O)	<i>n</i> -PrSO ₂	H	Et	H	77-85
41 (Ex. 1)	$-(CH_2)_2\text{-}$	N(r-Bu)	C(=O)	EtSO ₂	H	Et	H	164-167
42	$-(CH_2)_2\text{-}$	NH	C(=O)	EtSO ₂	H	Et	H	211-214
43	$-(CH_2)_2\text{-}$	NMe	C(=O)	EtSO ₂	H	Me	H	172-174
44	$-(CH_2)_2\text{-}$	N(r-Bu)	C(=O)	EtSO ₂	H	Me	H	175-177

^a Compound contains approximately 43% by weight of 7-(ethylsulfonyl)-1,3-dihydro-1-oxo-4-isobenzofurancarboxylic acid.

*See Index Table E for ¹H NMR data.

INDEX TABLE E

Cmpd No.	¹ H NMR Data (CDCl ₃ solution unless indicated otherwise) ^a
4	δ 0.94 (d,6H), 2.05 (m,1H), 2.11 (m,2H), 2.51 (t,2H), 2.82 (t,2H), 3.96 (d,2H), 4.26 (s,2H), 7.35 (s,1H), 7.35 (d,1H), 7.98 (d,1H).
17	δ 1.4 (s,6H), 1.9-2.1 (m,2H), 2.3-2.5 (m,4H), 2.6 (t,2H), 2.75 (br t,1H), 3.3-3.4 (m,2H), 7.5-7.7 (m,3H), 8.4 (br s,1H).
18	δ 1.65 (s,6H), 2.0-2.1 (m,2H), 2.3-2.6 (m,4H), 2.6 (t,J=6.9 Hz,1H), 2.8 (t,J=6.3 Hz,1H), 3.2-3.4 (m,2H), 7.6-7.7 (m,2H) (acidic hydrogen not observed).

30 δ 1.32 (d,J=7.24 Hz,3H), 1.47 (t,J=7.24 Hz,3H), 2.22 (s,3H), 2.52 (s,3H),
 3.10 (d,J=13.25 Hz,1H), 3.33 (dd,J=13.25, 8.07 Hz,1H), 4.06
 (q,J=7.24 Hz,2H), 7.14 (s,1H), 7.50-7.55 (m,2H), 7.68-7.74 (m,1H), 7.85
 (s,1H), 7.89-7.95 (m,2H).

34 δ 1.32 (s,9H), 2.31 (s,3H), 2.63 (s,3H), 3.09 (dd,J=16.20, 10.02 Hz,1H),
 3.23 (dd,J=16.2, 8.18 Hz,1H), 3.39 (dd,J=10.02, 8.18 Hz,1H), 3.72
 (s,3H), 7.25 (s,1H), 7.34 (s,1H).

38 (Me₂SO-*d*₆) δ 1.13 (t,J=7.5 Hz,3H), 1.29 (t,J=7.2 Hz,3H), 3.74
 (q,J=7.5 Hz,2H), 4.03 (q,J=7.5 Hz,2H), 5.76 (s,1H), 7.80 (s,1H), 8.22
 (d,J=7.8 Hz,1H), 8.42 (d,J=7.8 Hz,1H).

^a ¹H NMR data are in ppm downfield from tetramethylsilane. Couplings are designated by (s)-singlet, (d)-doublet, (t)-triplet, (q)-quartet, (m)-multiplet, (dd)-doublet of doublets, (br s)-broad singlet, (br t)-broad triplet.

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BIOLOGICAL EXAMPLES OF THE INVENTION

TEST A

Seeds of barley (*Hordeum vulgare*), barnyardgrass (*Echinochloa crus-galli*), bedstraw (*Galium aparine*), blackgrass (*Alopecurus myosuroides*), chickweed (*Stellaria media*), cocklebur (*Xanthium strumarium*), corn (*Zea mays*), cotton (*Gossypium hirsutum*), crabgrass (*Digitaria sanguinalis*), downy brome (*Bromus tectorum*), giant foxtail (*Setaria faberii*), lambsquarters (*Chenopodium album*), morningglory (*Ipomoea hederacea*), rape (*Brassica napus*), rice (*Oryza sativa*), sorghum (*Sorghum bicolor*), soybean (*Glycine max*), sugar beet (*Beta vulgaris*), velvetleaf (*Abutilon theophrasti*), wheat (*Triticum aestivum*), wild buckwheat (*Polygonum convolvulus*), wild oat (*Avena fatua*) and purple nutsedge (*Cyperus rotundus*) tubers were planted and treated preemergence with test chemicals formulated in a non-phytotoxic solvent mixture which includes a surfactant.

At the same time, these crop and weed species were also treated with postemergence applications of test chemicals formulated in the same manner. Plants ranged in height from two to eighteen cm (one to four leaf stage) for postemergence treatments. Treated plants and controls were maintained in a greenhouse for twelve to sixteen days, after which all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table A, are based on a scale of 0 to 10 where 0 is no effect and 10 is complete control. A dash (-) response means no test result.

TABLE A	COMPOUND	TABLE A	COMPOUND
Rate 2000 g/ha	2 19 20 38	Rate 2000 g/ha	2 19 20 38
POSTEMERGENCE			PREEMERGENCE
Barley	9 0 7 0	Barley	4 0 4 0
Barnyardgrass	9 9 9 9	Barnyardgrass	10 0 10 1
Bedstraw	9 9 9 9	Bedstraw	8 0 9 2
Blackgrass	9 0 9 1	Blackgrass	7 0 6 0
Chickweed	9 9 9 8	Chickweed	9 0 9 9
Cocklebur	9 9 9 6	Cocklebur	8 0 7 0
Corn	9 7 9 0	Corn	2 0 3 2
Cotton	10 10 10 6	Cotton	7 0 6 0
Crabgrass	9 5 9 2	Crabgrass	9 0 10 1
Downy brome	9 0 3 1	Downy brome	9 0 2 1
Giant foxtail	9 6 9 0	Giant foxtail	7 4 9 2
Lambsquarter	9 9 9 9	Lambsquarter	10 9 10 9
Morningglory	10 8 9 2	Morningglory	10 0 3 0
Nutsedge	7 6 8 1	Nutsedge	9 0 4 -
Rape	10 9 10 4	Rape	10 0 10 1
Rice	9 8 9 0	Rice	9 7 9 0
Sorghum	9 2 9 3	Sorghum	8 0 9 0
Soybean	9 8 9 4	Soybean	9 0 9 0
Sugar beet	10 10 10 9	Sugar beet	10 - 10 9
Velvetleaf	10 9 10 6	Velvetleaf	10 6 10 0
Wheat	9 1 7 0	Wheat	9 0 6 0
Wild buckwheat	10 9 10 9	Wild buckwheat	9 0 9 3
Wild oat	9 4 8 0	Wild oat	8 0 9 0

TABLE A COMPOUND

Rate 1000 g/ha	4	6	7	8	39	40	41	42	43	44
POSTEMERGENCE										
Barley	0	1	5	1	0	0	4	0	0	1
Barnyardgrass	7	9	9	9	8	4	9	9	9	10
Bedstraw	7	6	8	4	5	8	9	5	8	9
Blackgrass	1	2	3	2	2	0	4	2	3	7
Chickweed	8	9	9	8	8	9	9	6	8	10
Cocklebur	8	8	10	8	9	8	9	7	7	9
Corn	1	0	1	3	0	0	7	1	0	8
Cotton	5	9	10	7	3	4	8	2	6	10
Crabgrass	8	9	9	9	9	1	9	4	9	9
Downy brome	0	1	4	1	0	0	2	1	0	3
Giant foxtail	1	1	6	4	3	0	9	3	8	9
Lambsquarter	8	9	8	9	9	9	9	9	9	9
Morningglory	9	9	10	9	9	5	9	3	8	10
Nutsedge	0	0	5	4	0	0	-	0	1	7
Rape	8	9	7	9	8	6	10	8	10	10
Rice	7	9	7	8	8	6	9	4	9	10
Sorghum	4	2	3	6	5	1	10	1	1	10
Soybean	7	7	9	5	6	6	8	3	4	8
Sugar beet	10	10	10	10	10	9	10	9	10	10
Velvetleaf	7	9	9	9	9	2	9	3	5	9
Wheat	1	2	4	2	0	0	7	1	2	4
Wild buckwheat	8	7	10	6	6	7	8	5	7	9
Wild oat	1	2	2	2	0	0	10	3	9	8

TABLE A	COMPOUND										
	Rate 1000 g/ha	4	6	7	8	39	40	41	42	43	44
PREEMERGENCE											
Barley	0	0	1	0	0	0	0	0	0	0	0
Barnyardgrass	1	3	0	3	0	0	9	0	4	10	
Bedstraw	3	0	4	0	0	0	8	1	0	8	
Blackgrass	0	0	0	0	0	0	5	0	0	2	
Chickweed	8	3	7	7	0	6	9	0	0	10	
Cocklebur	3	0	8	6	2	0	7	0	0	8	
Corn	0	0	0	0	0	0	0	0	0	0	
Cotton	5	0	8	0	0	0	7	0	0	6	
Crabgrass	3	7	10	9	7	0	10	0	5	10	
Downy brome	0	0	5	0	0	0	0	1	0	0	
Giant foxtail	1	0	5	0	1	0	8	0	2	8	
Lambsquarter	9	10	9	9	9	8	9	9	7	9	
Morningglory	7	7	8	6	2	0	10	1	2	8	
Nutsedge	-	0	9	0	0	0	8	0	0	5	
Rape	4	2	5	2	3	0	8	2	0	9	
Rice	8	3	7	1	0	0	9	0	2	8	
Sorghum	4	0	0	0	0	0	9	0	0	3	
Soybean	0	0	7	0	0	0	3	0	0	6	
Sugar beet	10	10	10	9	9	3	10	3	0	10	
Velvetleaf	6	2	9	7	8	0	10	0	1	10	
Wheat	0	0	0	0	0	0	0	0	0	0	
Wild buckwheat	5	2	8	1	0	0	6	0	0	8	
Wild oat	0	0	0	0	0	0	4	0	0	3	

TABLE A COMPOUND

Rate 400 g/ha	1	2	17	18	19	20	24	36	37	38
POSTEMERGENCE										
Barley	2	8	0	4	0	4	1	0	1	0
Barnyardgrass	9	9	5	9	9	9	9	9	9	8
Bedstraw	9	9	3	8	9	9	7	8	9	6
Blackgrass	0	9	1	3	0	8	1	1	5	0
Chickweed	9	9	6	8	9	9	9	9	9	7
Cocklebur	9	9	5	9	9	9	9	8	9	6
Corn	0	8	0	0	2	8	5	0	0	0
Cotton	10	10	1	9	7	10	9	8	8	3
Crabgrass	9	9	4	9	1	9	4	9	9	0
Downy brome	0	8	0	2	0	0	0	0	3	0
Giant foxtail	4	9	3	9	3	9	4	8	8	0
Lambsquarter	-	9	5	8	9	9	9	9	9	8
Morningglory	9	10	6	9	3	9	3	8	9	2
Nutsedge	1	7	0	2	-	7	2	0	-	0
Rape	9	10	4	8	9	10	7	10	10	2
Rice	8	9	2	7	8	9	7	9	8	0
Sorghum	6	9	1	7	0	9	4	0	1	2
Soybean	8	9	3	8	8	9	6	6	7	3
Sugar beet	10	10	10	9	9	10	10	10	10	8
Velvetleaf	8	10	7	10	9	10	9	8	8	5
Wheat	2	9	0	7	1	6	1	1	6	0
Wild buckwheat	9	10	2	8	9	9	9	4	6	6
Wild oat	0	9	1	0	2	8	2	8	8	0

TABLE A
COMPOUND

Rate 400 g/ha	1	2	17	18	19	20	24	36	37	38
PREEMERGENCE										
Barley	0	2	0	0	0	2	0	0	0	0
Barnyardgrass	2	3	0	3	0	9	0	8	0	0
Bedstraw	4	7	0	0	0	8	0	0	7	1
Blackgrass	0	1	0	0	0	2	0	0	0	0
Chickweed	7	8	0	7	0	8	6	3	8	4
Cocklebur	0	8	0	5	0	5	0	3	0	0
Corn	1	0	0	0	0	0	0	0	2	0
Cotton	1	3	0	2	0	6	0	0	0	0
Crabgrass	9	10	0	7	0	10	7	2	8	0
Downy brome	0	5	0	0	0	0	1	1	2	0
Giant foxtail	1	3	0	0	0	7	0	1	3	0
Lambsquarter	-	10	0	9	9	10	9	9	9	9
Morningglory	9	8	0	0	0	2	0	1	0	0
Nutsedge	0	3	0	0	-	4	0	0	-	0
Rape	0	10	0	0	0	8	0	2	7	0
Rice	1	8	0	6	4	9	0	0	0	0
Sorghum	0	3	0	2	0	6	0	0	0	0
Soybean	3	8	0	0	0	6	0	0	4	0
Sugar beet	10	10	0	8	4	10	8	8	10	8
Velvetleaf	0	10	0	6	4	10	0	0	2	0
Wheat	0	6	0	0	0	3	0	0	0	0
Wild buckwheat	6	8	0	0	0	3	0	0	2	0
Wild oat	0	4	0	0	0	3	0	0	0	0

TABLE A

COMPOUND

Rate 200 g/ha	3	4	5	6	7	8	21	22	23	29	39	40	41	42	43	44
POSTEMERGENCE																
Barley	8	0	9	0	1	0	8	3	1	7	0	0	1	0	0	0
Barnyardgrass	9	1	10	2	4	8	9	9	4	10	3	1	9	4	9	9
Bedstraw	10	7	10	2	8	2	9	9	9	9	-	8	8	4	8	9
Blackgrass	6	0	7	0	2	0	8	6	2	8	0	0	2	0	0	3
Chickweed	9	8	9	5	9	7	9	10	9	9	6	7	9	5	7	10
Cocklebur	9	7	9	3	8	7	9	10	8	10	8	5	9	4	6	9
Corn	5	1	4	0	0	1	7	7	0	3	0	0	4	0	0	7
Cotton	10	5	9	3	10	7	9	10	9	3	3	2	7	2	3	9
Crabgrass	9	5	9	6	3	2	9	9	9	9	3	0	8	1	3	9
Downy brome	8	0	8	0	2	0	3	3	1	4	0	0	1	0	0	0
Giant foxtail	8	0	9	0	2	1	9	9	5	9	1	0	9	0	3	9
Lambsquarter	10	7	9	6	8	1	9	9	8	10	9	9	9	4	6	9
Morningglory	9	9	9	9	10	8	2	9	6	8	8	2	9	2	3	9
Nutsedge	3	-	6	0	1	0	-	9	7	9	0	0	3	0	0	4
Rape	10	4	10	8	4	7	10	10	9	10	6	6	9	3	7	10
Rice	10	6	9	4	3	5	10	10	9	9	6	5	9	0	2	10
Sorghum	9	1	8	0	1	2	8	9	2	9	4	0	7	0	0	7
Soybean	9	6	9	5	8	5	9	9	8	9	5	4	6	2	2	8
Sugar beet	10	10	10	10	10	10	10	10	10	10	9	10	9	9	10	
Velvetleaf	10	7	9	8	8	8	10	10	10	10	8	1	9	2	2	9
Wheat	9	0	7	0	3	0	8	7	0	10	0	0	4	0	0	2
Wild buckwheat	10	7	10	2	10	1	9	10	9	10	5	3	5	-	6	7
Wild oat	2	0	6	0	0	1	9	8	4	10	0	0	9	0	0	6

TABLE A

COMPOUND

Rate 200 g/ha	3	4	5	6	7	8	21	22	23	29	39	40	41	42	43	44
PREEMERGENCE																
Barley	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barnyardgrass	4	0	7	0	0	0	9	8	0	10	0	0	6	0	0	3
Bedstraw	6	0	7	0	3	0	1	5	0	8	0	0	3	0	-	3
Blackgrass	3	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0
Chickweed	9	2	10	0	6	0	9	8	0	-	0	0	9	0	0	8
Cocklebur	9	0	3	-	4	0	7	3	0	8	0	0	5	0	0	4
Corn	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Cotton	3	0	3	0	2	0	0	4	0	2	0	0	2	0	0	0
Crabgrass	9	1	10	0	7	0	7	9	0	8	1	0	8	0	0	9
Downy brome	2	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0
Giant foxtail	1	1	3	0	0	0	6	7	0	9	0	0	6	0	0	7
Lambsquarter	9	7	9	9	9	4	9	10	0	-	7	4	9	8	6	9
Morningglory	8	2	5	0	6	0	0	0	2	0	0	0	9	0	0	6
Nutsedge	-	-	3	0	3	0	-	-	0	10	0	0	0	0	0	0
Rape	8	2	9	1	2	0	8	9	0	4	0	0	6	0	0	8
Rice	9	3	7	0	2	0	10	9	0	9	0	0	3	0	0	2
Sorghum	1	0	3	0	0	0	3	5	0	5	0	0	4	0	0	0
Soybean	9	0	2	0	5	0	6	7	2	5	0	0	0	0	0	0
Sugar beet	10	8	10	8	10	2	2	10	0	-	6	0	9	0	0	9
Velvetleaf	10	1	10	0	2	0	10	9	1	10	1	0	8	0	0	9
Wheat	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Wild buckwheat	2	0	6	0	7	0	1	3	0	4	0	0	4	0	0	2
Wild oat	0	0	0	0	0	0	3	0	0	7	0	0	1	0	0	0

TABLE A		COMPOUND						TABLE A		COMPOUND					
Rate	100 g/ha	1	17	18	24	36	37	Rate	100 g/ha	1	17	18	24	36	37
POSTEMERGENCE								PREEMERGENCE							
Barley		0	0	3	0	0	0	Barley		0	0	0	0	0	0
Barnyardgrass		6	-	8	9	9	9	Barnyardgrass		0	0	0	0	0	0
Bedstraw		6	0	8	7	3	8	Bedstraw		0	0	0	0	0	3
Blackgrass		0	0	0	0	0	1	Blackgrass		0	0	0	0	0	0
Chickweed		8	0	8	9	3	-	Chickweed		6	0	6	0	0	0
Cocklebur		7	0	9	9	6	8	Cocklebur		-	0	0	0	0	0
Corn		0	-	0	2	0	0	Corn		0	0	0	0	0	0
Cotton		7	-	5	8	7	2	Cotton		0	0	1	0	0	0
Crabgrass		6	2	8	4	3	8	Crabgrass		1	0	3	2	0	3
Downy brome		0	0	0	0	0	0	Downy brome		0	0	0	0	1	1
Giant foxtail		2	0	6	3	4	4	Giant foxtail		0	0	0	0	0	1
Lambsquarter		-	0	8	9	8	9	Lambsquarter		-	0	9	9	9	9
Morningglory		9	2	8	2	7	6	Morningglory		6	0	0	0	0	0
Nutsedge		0	0	1	1	0	2	Nutsedge		-	0	0	0	0	-
Rape		3	1	7	3	2	9	Rape		0	0	0	0	0	2
Rice		3	0	8	4	7	7	Rice		1	0	2	0	0	0
Sorghum		0	-	6	2	0	0	Sorghum		0	0	0	0	0	0
Soybean		7	-	8	6	4	4	Soybean		0	0	0	0	0	0
Sugar beet		10	8	9	10	9	9	Sugar beet		9	0	2	2	7	9
Velvetleaf		2	3	10	8	5	7	Velvetleaf		0	0	2	0	0	0
Wheat		0	0	2	1	0	1	Wheat		0	0	0	0	0	0
Wild buckwheat		7	1	3	9	1	6	Wild buckwheat		3	0	0	0	0	0
Wild oat		0	0	0	1	1	4	Wild oat		0	0	0	0	0	0

TABLE A

COMPOUND

Rate	50 g/ha	3	5	9	10	11	21	22	23	25	26	27	28	29
POSTEMERGENCE														
Barley		5	7	6	2	3	7	0	0	1	3	1	2	1
Barnyardgrass		9	9	9	9	9	9	2	9	9	9	9	9	10
Bedstraw		8	9	9	8	9	9	8	8	7	8	7	7	8
Blackgrass		3	1	4	4	5	2	3	0	6	8	7	3	8
Chickweed		9	7	9	9	9	9	10	9	9	9	9	9	9
Cocklebur		9	8	9	9	9	9	10	8	10	10	9	10	9
Corn		0	0	1	1	5	4	3	0	2	1	1	6	2
Cotton		10	9	9	10	9	7	9	9	9	10	9	10	10
Crabgrass		9	8	10	9	6	9	9	6	10	9	9	9	3
Downy brome		6	2	3	3	3	0	2	0	3	3	2	1	2
Giant foxtail		1	6	5	2	2	9	9	2	9	9	7	7	9
Lambsquarter		9	9	9	10	9	9	9	8	9	9	9	9	10
Morningglory		9	9	10	9	9	2	9	1	9	3	1	9	3
Nutsedge		0	3	3	6	2	-	8	2	6	4	3	3	3
Rape		9	9	10	10	10	9	9	7	8	10	9	10	8
Rice		9	9	10	9	10	9	9	9	9	10	9	10	9
Sorghum		8	5	4	2	3	6	6	0	6	8	8	5	8
Soybean		9	8	9	9	6	8	9	7	9	9	8	9	9
Sugar beet		10	10	10	10	10	9	10	9	10	10	10	10	10
Velvetleaf		10	9	10	10	10	9	10	9	9	10	9	9	9
Wheat		5	4	8	5	7	6	3	0	5	8	8	6	9
Wild buckwheat		7	10	9	8	7	9	10	8	9	7	8	9	9
Wild oat		1	2	5	3	5	5	5	1	6	6	7	5	9

TABLE A

COMPOUND

Rate 50 g/ha	3	5	9	10	11	21	22	23	25	26	27	28	29
PREEMERGENCE													
Barley	0	0	0	0	0	0	0	0	0	0	0	0	0
Barnyardgrass	0	0	8	0	2	2	7	0	0	5	0	1	1
Bedstraw	0	-	8	4	4	0	4	0	9	4	5	3	-
Blackgrass	1	0	0	0	0	0	0	0	0	0	0	0	0
Chickweed	2	5	8	7	7	7	5	0	8	8	7	7	-
Cocklebur	5	0	7	3	3	7	0	0	0	1	0	-	4
Corn	0	0	0	0	0	0	0	0	0	0	0	0	0
Cotton	0	0	0	0	0	0	0	0	0	0	0	0	0
Crabgrass	8	7	10	6	8	7	6	0	6	9	8	7	3
Downy brome	0	0	0	0	0	0	0	0	0	0	0	0	0
Giant foxtail	0	1	1	0	1	4	2	0	2	2	2	2	1
Lambsquarter	9	8	10	10	9	9	7	0	9	10	9	8	-
Morningglory	6	0	4	1	1	0	0	0	0	0	2	0	0
Nutsedge	-	0	0	0	1	-	0	0	0	0	-	0	0
Rape	2	1	6	4	7	2	7	0	5	0	0	0	-
Rice	0	0	7	0	3	4	5	0	4	4	3	3	6
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0	1
Soybean	8	0	0	0	0	0	2	0	10	0	0	0	2
Sugar beet	8	8	10	10	10	1	7	0	8	7	8	0	-
Velvetleaf	9	4	10	8	8	6	1	1	6	6	7	6	8
Wheat	0	0	0	0	0	0	0	0	0	0	0	0	0
Wild buckwheat	0	0	2	0	3	0	2	0	0	4	0	3	-
Wild oat	0	0	0	0	0	0	0	0	0	0	0	0	2

TABLE A COMPOUND

Rate 10 g/ha	9	10	11	25	26	27	28
POSTEMERGENCE							
Barley	3	0	0	0	1	0	0
Barnyardgrass	8	4	4	9	9	7	2
Bedstraw	7	7	8	7	6	5	7
Blackgrass	3	1	1	0	3	4	0
Chickweed	9	6	6	9	8	8	8
Cocklebur	9	9	8	9	10	9	9
Corn	0	0	0	0	0	0	0
Cotton	9	9	8	9	6	7	8
Crabgrass	8	6	2	8	9	7	5
Downy brome	1	0	0	0	0	1	0
Giant foxtail	2	0	0	3	6	2	2
Lambsquarter	9	9	9	8	9	8	8
Morningglory	9	9	9	7	2	1	5
Nutsedge	2	1	0	1	2	2	0
Rape	8	8	7	6	5	7	8
Rice	9	5	7	6	9	9	8
Sorghum	2	2	1	2	2	4	2
Soybean	7	8	5	8	7	6	7
Sugar beet	10	9	9	10	9	10	10
Velvetleaf	10	9	9	9	9	7	8
Wheat	6	2	3	1	4	4	3
Wild buckwheat	3	2	5	3	2	3	2
Wild oat	3	0	3	2	3	3	3

TABLE A COMPOUND

Rate 10 g/ha	9	10	11	25	26	27	28
PREEMERGENCE							
Barley	0	0	0	0	0	0	0
Barnyardgrass	1	0	0	0	1	0	0
Bedstraw	-	-	3	9	0	4	2
Blackgrass	0	0	0	0	0	0	0
Chickweed	6	0	0	6	0	0	0
Cocklebur	5	0	0	0	0	0	-
Corn	0	0	0	0	0	0	0
Cotton	0	0	0	0	0	0	-
Crabgrass	2	1	1	2	4	2	2
Downy brome	0	0	0	0	0	0	0
Giant foxtail	0	0	0	0	0	0	0
Lambsquarter	8	8	5	8	0	0	2
Morningglory	0	0	0	-	0	0	-
Nutsedge	0	0	0	0	0	0	0
Rape	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0
Soybean	0	0	0	1	0	0	0
Sugar beet	8	3	6	6	0	3	0
Velvetleaf	8	2	6	2	4	2	0
Wheat	0	0	0	0	0	0	0
Wild buckwheat	0	0	0	0	0	0	0
Wild oat	0	0	0	0	0	0	0

TEST B

The compounds evaluated in this test were formulated in a non-phytotoxic solvent mixture which includes a surfactant and applied to the soil surface before plant 5 seedlings emerged (preemergence application), to water that covered the soil surface (flood application), and to plants that were in the one-to-four leaf stage (postemergence application). A sandy loam soil was used for the preemergence and postemergence tests, while a silt loam soil was used in the flood test. Water depth was approximately 2.5 cm for the flood test and was maintained at this level for the duration of the test.

10 Plant species in the preemergence and postemergence tests consisted of barnyardgrass (*Echinochloa crus-galli*), barley (*Hordeum vulgare*), bedstraw (*Galium aparine*), blackgrass (*Alopecurus myosuroides*), chickweed (*Stellaria media*), cocklebur

(*Xanthium strumarium*), corn (*Zea mays*), cotton (*Gossypium hirsutum*), crabgrass (*Digitaria sanguinalis*), downy brome (*Bromus tectorum*), giant foxtail (*Setaria faberii*), johnsongrass (*Sorghum halpense*), lambsquarters (*Chenopodium album*), morningglory (*Ipomoea hederacea*), pigweed (*Amaranthus retroflexus*), rape (*Brassica napus*),
5 ryegrass (*Lolium multiflorum*), soybean (*Glycine max*), speedwell (*Veronica persica*), sugar beet (*Beta vulgaris*), velvetleaf (*Abutilon theophrasti*), wheat (*Triticum aestivum*), wild buckwheat (*Polygonum convolvulus*), and wild oat (*Avena fatua*). All plant species were planted one day before application of the compound for the preemergence portion
10 of this test. Plantings of these species were adjusted to produce plants of appropriate size for the postemergence portion of the test. Plant species in the flood test consisted of rice (*Oryza sativa*), umbrella sedge (*Cyperus difformis*), duck salad (*Heteranthera limosa*), barnyardgrass (*Echinochloa crus-galli*) and Late watergrass (*Echinochloa oryzicola*) grown to the 2 leaf stage for testing.

15 All plant species were grown using normal greenhouse practices. Visual evaluations of injury expressed on treated plants, when compared to untreated controls, were recorded approximately fourteen to twenty one days after application of the test compound. Plant response this ratings, summarized in Table B, were recorded on a 0 to 100 scale where 0 is no effect and 100 is complete control. A dash (-) response means no test result.

TABLE B COMPOUND

Rate 500 g/ha 43

POSTEMERGENCE

Barley Igri 0

Barnyard Flood 0

Barnyardgrass 90

Bedstraw 90

Blackgrass 10

Chickweed 65

Cocklebur 70

Corn 0

Cotton 50

Crabgrass 80

Downy Brome 0

Duck salad 0

Giant foxtail 70

Italn. Ryegrass 0

Johnsongrass 30

Lambsquarter 65

Morningglory 40

Rape 85

Redroot Pigweed 50

Rice Japonica 0

Soybean 40

Speedwell 100

Sugar beet 20

Umbrella sedge 35

Velvetleaf 70

Watergrass 2 -

Wheat 0

Wild buckwheat 10

Wild oat 30

TABLE B COMPOUND

Rate 500 g/ha 43

PREEMERGENCE

Barley Igri 0

Barnyardgrass 10

Bedstraw 100

Blackgrass 0

Chickweed 0

Cocklebur 10

Corn 0

Cotton 0

Crabgrass 30

Downy Brome 0

Giant foxtail 0

Italn. Ryegrass 10

Johnsongrass 0

Lambsquarter 95

Morningglory 20

Rape 0

Redroot Pigweed 60

Soybean 0

Speedwell 0

Sugar beet 0

Velvetleaf 0

Wheat 0

Wild buckwheat 0

Wild oat 0

TABLE B		COMPOUND
Rate	250 g/ha	24 43
POSTEMERGENCE		
Barley Igri	-	0
Barnyard Flood	0	0
Barnyardgrass	-	90
Bedstraw	-	80
Blackgrass	-	0
Chickweed	-	65
Cocklebur	-	70
Corn	-	0
Cotton	-	30
Crabgrass	--	-
Downy Brome	-	0
Duck salad	0	0
Giant foxtail	-	-
Italn. Ryegrass	-	0
Johnsongrass	-	30
Lambsquarter	-	65
Morningglory	-	-
Rape	-	20
Redroot Pigweed	-	-
Rice Japonica	0	0
Soybean	-	40
Speedwell	-	100
Sugar beet	-	0
Umbrella sedge	0	30
Velvetleaf	-	-
Watergrass 2	-	-
Wheat	-	0
Wild buckwheat	-	0
Wild oat	-	10

TABLE B		COMPOUND
Rate	250 g/ha	43
PREEMERGENCE		
Barley Igri		0
Barnyardgrass		0
Bedstraw		0
Blackgrass		0
Chickweed		0
Cocklebur		0
Corn		0
Cotton		0
Crabgrass		0
Downy Brome		0
Giant foxtail		0
Italn. Ryegrass		0
Johnsongrass		0
Lambsquarter		0
Morningglory		0
Rape		0
Redroot Pigweed		20
Soybean		0
Speedwell		0
Sugar beet		0
Velvetleaf		0
Wheat		0
Wild buckwheat		0
Wild oat		0

TABLE B COMPOUND

Rate 125 g/ha	2	5	18	20	24	37	41	43
POSTEMERGENCE								
Barley Igri	75	60	0	20	-	0	0	0
Barnyard Flood	75	20	35	90	0	45	30	0
Barnyardgrass	100	95	65	100	-	90	90	70
Bedstraw	90	95	65	90	-	80	80	40
Blackgrass	90	85	10	80	-	10	0	0
Chickweed	100	95	85	100	-	95	90	10
Cocklebur	90	90	90	100	-	90	90	50
Corn	40	20	0	45	-	0	0	0
Cotton	100	95	90	100	-	70	80	30
Crabgrass	95	90	80	95	-	90	90	50
Downy Brome	85	0	0	0	-	0	0	0
Duck salad	40	35	0	10	0	15	20	0
Giant foxtail	95	85	60	95	-	80	90	30
Italn. Ryegrass	30	10	0	10	-	0	0	0
Johnsongrass	80	40	40	80	-	0	40	30
Lambsquarter	100	95	95	100	-	80	80	50
Morningglory	95	90	50	95	-	85	90	30
Rape	100	100	95	95	-	95	90	10
Redroot Pigweed	90	90	90	95	-	80	90	40
Rice Japonica	90	10	30	95	0	25	15	0
Soybean	90	90	55	90	-	40	60	30
Speedwell	100	95	75	100	-	100	100	0
Sugar beet	100	100	100	100	-	100	100	0
Umbrella sedge	75	25	0	30	0	20	25	20
Velvetleaf	100	100	90	100	-	90	90	50
Watergrass 2	75	-	25	95	-	40	-	-
Wheat	75	40	0	0	-	0	0	0
Wild buckwheat	90	95	75	95	-	20	30	0
Wild oat	70	25	0	40	-	0	50	0

Rate PREEMERGENCE	125 g/ha	COMPOUND						
		2	5	18	20	37	41	43
Barley Igri		0	0	0	0	0	0	0
Barnyardgrass		90	80	0	100	50	60	0
Bedstraw		90	100	0	60	0	0	0
Blackgrass		10	0	10	0	0	0	0
Chickweed		95	60	10	95	95	90	0
Cocklebur		90	30	0	60	0	60	0
Corn		0	0	0	0	0	10	0
Cotton		90	0	0	20	0	0	0
Crabgrass		100	100	0	100	30	60	0
Downy Brome		0	0	0	0	0	0	0
Giant foxtail		20	10	10	100	20	60	0
Italn. Ryegrass		0	0	0	0	0	10	0
Johnsongrass		10	30	0	70	0	30	0
Lambsquarter		95	100	95	100	95	95	0
Morningglory		90	60	0	90	0	60	0
Rape		100	100	0	95	0	10	0
Redroot Pigweed		80	80	80	100	40	90	10
Soybean		85	20	0	40	0	10	0
Speedwell		100	95	10	95	0	100	0
Sugar beet		100	100	100	100	0	100	0
Velvetleaf		100	100	20	100	0	80	0
Wheat		0	0	0	0	0	0	0
Wild buckwheat		25	0	10	0	0	10	0
Wild oat		0	0	0	0	0	0	0

TABLE B

COMPOUND

Rate POSTEMERGENCE	62 g/ha	2	3	5	18	20	21	24	37	41	43
Barley Igri	70	30	30	0	0	0	-	0	0	0	0
Barnyard Flood	35	20	0	20	85	55	0	25	25	0	0
Barnyardgrass	95	95	90	55	95	95	-	90	90	60	
Bedstraw	90	85	90	60	75	80	-	80	80	30	
Blackgrass	20	80	40	0	20	65	-	0	0	0	
Chickweed	100	90	90	85	100	90	-	90	90	10	
Cocklebur	90	90	90	80	90	90	-	70	90	50	
Corn	0	0	10	0	0	20	-	0	0	0	
Cotton	100	100	80	80	95	90	-	50	80	10	
Crabgrass	90	90	90	70	95	90	-	75	90	30	
Downy Brome	40	25	0	0	0	0	-	0	0	0	
Duck salad	30	25	25	0	10	40	0	0	0	0	
Giant foxtail	90	30	75	35	95	90	-	50	70	10	
Italn. Ryegrass	0	20	0	0	10	20	-	0	0	0	
Johnsongrass	55	50	30	30	80	50	-	0	20	20	
Lambsquarter	100	100	95	95	100	100	-	80	80	50	
Morningglory	95	90	90	30	95	90	-	70	90	20	
Rape	100	95	100	90	95	95	-	90	60	0	
Redroot Pigweed	80	85	90	80	95	90	-	80	75	30	
Rice Japonica	40	0	0	15	95	45	0	25	0	0	
Soybean	90	90	90	40	90	90	-	40	50	30	
Speedwell	100	90	95	75	95	100	-	90	100	0	
Sugar beet	100	100	100	100	100	95	-	95	100	0	
Umbrella sedge	70	25	20	0	25	45	0	10	25	0	
Velvetleaf	100	95	100	90	100	90	-	70	90	20	
Watergrass 2	65	-	-	20	95	-	-	20	-	-	
Wheat	40	40	20	0	0	40	-	0	0	0	
Wild buckwheat	80	95	90	65	70	90	-	10	0	0	
Wild oat	20	15	0	0	40	40	-	0	50	0	

TABLE B

COMPOUND

Rate 62 g/ha	2	3	5	18	20	21	37	41	43
PREEMERGENCE									
Barley Igri	0	0	0	0	0	0	0	0	0
Barnyardgrass	50	10	30	0	95	30	20	10	0
Bedstraw	70	0	50	0	60	10	0	0	0
Blackgrass	0	0	0	0	0	0	0	0	0
Chickweed	90	35	60	0	95	10	45	65	0
Cocklebur	80	50	30	0	40	0	0	10	0
Corn	0	0	0	0	0	0	0	0	0
Cotton	70	0	0	0	0	0	0	0	0
Crabgrass	90	90	60	0	100	50	30	50	0
Downy Brome	0	0	0	0	0	0	0	0	0
Giant foxtail	0	0	10	0	95	30	0	20	0
Italn. Ryegrass	0	0	0	0	0	0	0	0	0
Johnsongrass	0	0	0	-	40	0	0	30	0
Lambsquarter	95	95	100	95	95	95	95	95	0
Morningglory	90	50	30	0	60	0	0	60	0
Rape	100	0	90	0	40	0	0	0	0
Redroot Pigweed	40	30	60	20	60	50	40	70	0
Soybean	60	0	0	0	20	0	0	0	0
Speedwell	100	90	90	0	60	0	0	100	-
Sugar beet	100	95	100	10	100	0	0	100	0
Velvetleaf	100	100	100	0	100	90	0	30	0
Wheat	0	0	0	0	0	0	0	0	0
Wild buckwheat	0	0	0	0	0	10	0	0	0
Wild oat	0	0	0	0	0	10	0	0	0

TABLE B

COMPOUND

Rate 31 g/ha	2	3	5	9	10	18	20	21	22	24	25	26	37	41	44
POSTEMERGENCE															
Barley Igri	20	20	0	20	0	0	0	0	0	-	0	10	0	0	0
Barnyard Flood	30	15	0	-	-	15	30	35	15	0	-	-	10	10	0
Barnyardgrass	95	90	90	90	90	35	95	95	90	-	100	95	80	90	90
Bedstraw	90	80	90	90	60	40	75	80	95	-	55	60	30	80	65
Blackgrass	20	75	20	20	10	0	10	50	35	-	0	30	0	0	0
Chickweed	100	90	90	90	95	80	100	90	90	-	95	100	70	90	95
Cocklebur	90	90	80	90	90	50	90	90	90	-	90	90	50	90	90
Corn	0	0	0	0	5	0	0	0	10	-	10	10	0	0	0
Cotton	100	90	80	90	100	30	95	80	90	-	95	80	-	80	90
Crabgrass	90	80	85	70	80	70	95	90	90	-	90	90	50	80	80
Downy Brome	20	15	0	20	10	0	0	0	20	-	10	30	0	0	0
Duck salad	0	20	0	-	-	0	10	30	80	0	-	-	0	0	0
Giant foxtail	70	20	40	40	30	20	95	90	90	-	95	100	30	70	30
Italn. Ryegrass	0	20	0	20	0	0	0	10	25	-	0	20	0	0	0
Johnsongrass	45	50	20	40	30	20	75	50	50	-	60	70	0	10	20
Lambsquarter	100	95	95	95	100	90	100	95	100	-	90	100	70	70	65
Morningglory	95	90	90	90	90	20	95	90	90	-	80	40	70	90	90
Rape	100	80	95	100	100	90	95	90	90	-	100	40	90	60	95
Redroot Pigweed	70	80	70	70	50	75	95	80	90	-	60	80	70	75	40
Rice Japonica	30	0	0	-	-	15	90	35	25	0	-	-	0	0	10
Soybean	85	90	80	90	85	35	80	90	90	-	90	80	35	50	60
Speedwell	100	-	90	60	90	60	95	90	90	-	60	90	-	100	95
Sugar beet	100	95	100	100	90	90	100	95	100	-	70	90	65	100	100
Umbrella sedge	35	10	10	-	-	0	20	35	60	0	-	-	10	15	0
Velvetleaf	100	95	100	100	90	90	100	90	90	-	90	100	70	90	75
Watergrass	2	25	-	-	-	0	75	-	-	-	-	-	10	-	-
Wheat	10	20	0	50	0	0	0	10	0	-	20	40	0	0	0
Wild buckwheat	60	70	70	60	40	50	70	90	90	-	40	50	0	0	0
Wild oat	10	10	0	30	0	0	0	20	35	-	35	40	0	20	0

TABLE B

COMPOUND

Rate 31 g/ha	2	3	5	9	10	18	20	21	22	25	26	37	41	44
PREEMERGENCE														
Barley Igri	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barnyardgrass	20	0	20	70	30	0	30	10	70	40	85	0	0	0
Bedstraw	50	0	50	40	10	0	30	0	0	0	30	0	0	0
Blackgrass	0	0	0	30	0	0	0	0	0	0	20	0	0	0
Chickweed	70	35	0	95	80	0	90	10	50	90	100	0	0	0
Cocklebur	80	30	20	40	40	0	30	0	0	15	0	0	0	0
Corn	0	0	0	0	0	0	0	0	0	10	0	0	0	0
Cotton	30	0	0	0	10	0	0	0	0	0	0	0	0	10
Crabgrass	80	75	60	60	50	0	100	40	60	60	85	10	50	0
Downy Brome	0	0	0	0	0	0	0	0	0	0	10	0	0	0
Giant foxtail	0	0	0	0	0	0	85	20	30	50	45	0	0	0
Italn. Ryegrass	0	0	0	10	0	0	0	0	0	0	0	0	0	0
Johnsongrass	0	0	0	-	15	0	20	0	10	35	35	0	0	0
Lambsquarter	95	95	100	100	100	95	90	95	95	100	95	90	25	85
Morningglory	80	0	0	0	20	0	0	0	0	0	0	0	0	10
Rape	85	0	50	20	90	0	0	0	0	0	0	0	0	0
Redroot Pigweed	0	30	60	70	10	0	35	20	80	50	60	20	60	50
Soybean	40	0	0	0	50	0	10	0	0	10	20	0	0	20
Speedwell	95	85	70	90	100	0	40	0	100	80	70	0	100	85
Sugar beet	100	10	100	100	80	0	100	0	95	0	80	0	90	50
Velvetleaf	100	100	100	0	90	0	100	50	50	70	70	0	20	20
Wheat	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wild buckwheat	0	0	0	0	20	0	0	0	0	10	10	0	0	20
Wild oat	0	0	0	0	30	0	0	0	0	20	0	0	0	0

TABLE B

COMPOUND

Rate 16 g/ha	2	3	5	9	10	18	20	21	22	25	26	37	41	44
PREEMERGENCE														
Barley Igri	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barnyardgrass	0	0	0	20	20	0	10	0	30	30	20	0	0	0
Bedstraw	30	0	0	-	0	0	30	0	0	0	0	0	0	0
Blackgrass	0	0	0	10	0	0	0	0	0	0	10	0	0	0
Chickweed	70	25	0	70	10	0	65	0	50	60	100	0	0	0
Cocklebur	60	-	10	30	30	0	0	0	0	10	0	0	0	0
Corn	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cotton	20	0	0	20	0	0	0	0	0	0	0	0	0	0
Crabgrass	65	20	30	40	20	0	90	20	40	40	60	0	10	0
Downy Brome	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Giant foxtail	0	0	0	0	0	0	30	10	10	20	25	0	0	0
Italn. Ryegrass	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Johnsongrass	0	0	0	10	0	0	0	0	0	25	25	0	0	0
Lambsquarter	95	95	45	100	100	90	90	95	95	90	90	85	20	0
Morningglory	60	0	0	0	10	0	0	0	0	0	0	0	0	0
Rape	25	0	0	20	20	0	0	0	0	0	0	0	0	0
Redroot Pigweed	0	0	60	30	0	0	20	0	50	30	40	0	35	20
Soybean	30	0	0	0	40	0	0	0	0	10	20	0	0	20
Speedwell	90	0	-	80	10	0	10	0	100	50	20	0	100	0
Sugar beet	10	0	0	30	60	0	0	0	0	0	0	0	0	30
Velvetleaf	100	90	70	90	65	0	55	0	15	30	55	0	0	0
Wheat	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wild buckwheat	0	0	0	0	20	0	0	0	0	0	0	0	0	0
Wild oat	0	0	0	0	-	0	0	0	0	0	0	0	0	0

TABLE B

COMPOUND

Rate	8 g/ha	3	9	10	21	22	25	26	44
POSTEMERGENCE									
Barley Igri									
	0	0	0	0	0	0	0	0	0
Barnyard Flood									
	0	-	-	0	0	-	-	0	
Barnyardgrass									
	80	60	70	90	70	75	95	60	
Bedstraw									
	80	30	40	80	85	20	30	0	
Blackgrass									
	10	0	0	20	0	0	0	0	0
Chickweed									
	85	50	70	85	70	90	70	65	
Cocklebur									
	70	90	90	90	80	90	90	90	
Corn									
	0	0	0	0	0	0	0	0	0
Cotton									
	90	50	90	50	80	40	80	50	
Crabgrass									
	70	40	60	80	70	65	80	30	
Downy Brome									
	10	0	0	0	0	0	0	0	0
Duck salad									
	0	-	-	0	0	-	-	0	
Giant foxtail									
	0	10	10	60	50	70	70	0	
Italn. Ryegrass									
	10	0	0	0	0	0	0	0	0
Johnsongrass									
	30	10	10	10	20	25	40	10	
Lambsquarter									
	95	85	85	95	90	90	90	20	
Morningglory									
	85	80	90	90	90	30	20	80	
Rape									
	30	70	60	80	90	60	20	70	
Redroot Pigweed									
	70	40	30	30	70	30	40	20	
Rice Japonica									
	0	-	-	0	0	-	-	10	
Soybean									
	80	60	70	80	65	70	60	30	
Speedwell									
	90	40	50	70	85	50	-	50	
Sugar beet									
	90	70	50	80	95	60	90	95	
Umbrella sedge									
	0	-	-	0	0	-	-	0	
Velvetleaf									
	90	90	90	80	90	90	90	60	
Watergrass 2									
	-	-	-	-	-	-	-	-	
Wheat									
	10	20	0	0	0	0	20	0	
Wild buckwheat									
	60	10	10	85	90	10	10	0	
Wild oat									
	0	10	0	0	0	25	20	0	

TABLE B COMPOUND

Rate 8 g/ha	3	9	10	21	22	25	26	44
PREEMERGENCE								
Barley Igri	0	0	0	0	0	0	0	0
Barnyardgrass	0	0	10	0	10	10	0	0
Bedstraw	0	0	0	0	0	0	0	0
Blackgrass	0	0	0	0	0	0	0	0
Chickweed	20	30	0	0	0	60	100	0
Cocklebur	10	0	10	0	0	0	0	0
Corn	0	0	0	0	0	0	0	0
Cotton	0	0	0	0	0	0	0	0
Crabgrass	10	0	10	10	20	30	10	0
Downy Brome	0	0	0	0	0	0	0	0
Giant foxtail	0	0	0	0	0	10	0	0
Italn. Ryegrass	0	0	0	0	0	0	0	0
Johnsongrass	0	0	0	0	0	15	0	0
Lambsquarter	90	100	95	20	0	80	70	0
Morningglory	0	0	0	0	0	0	0	0
Rape	0	0	10	0	0	0	0	0
Redroot Pigweed	0	25	0	0	10	0	0	10
Soybean	0	0	10	0	0	0	0	0
Speedwell	0	80	0	0	45	50	0	-
Sugar beet	0	0	10	0	0	0	0	20
Velvetleaf	30	90	40	0	0	30	30	0
Wheat	0	0	0	0	0	0	0	0
Wild buckwheat	0	0	0	0	0	0	0	0
Wild oat	0	0	10	0	0	0	0	0

TABLE B

COMPOUND

Rate 4 g/ha	9	10	22	25	26	44
POSTEMERGENCE						
Barley Igri	0	0	0	0	0	0
Barnyard Flood	-	-	0	-	-	0
Barnyardgrass	50	40	50	35	90	30
Bedstraw	10	30	80	0	0	0
Blackgrass	0	0	0	0	0	0
Chickweed	20	20	70	90	70	-
Cocklebur	75	80	80	80	80	70
Corn	0	0	0	0	0	0
Cotton	50	40	60	40	40	40
Crabgrass	40	40	50	50	70	20
Downy Brome	0	0	0	0	0	0
Duck salad	-	-	0	-	-	0
Giant foxtail	0	0	20	40	50	-
Italn. Ryegrass	0	0	0	0	0	0
Johnsongrass	0	0	20	10	25	0
Lambsquarter	85	85	90	85	85	20
Morningglory	80	75	80	20	0	30
Rape	10	30	85	30	0	40
Redroot Pigweed	30	30	40	20	40	10
Rice Japonica	-	-	0	-	-	10
Soybean	50	65	50	50	35	30
Speedwell	40	0	60	-	20	0
Sugar beet	70	50	95	40	80	95
Umbrella sedge	-	-	0	-	-	0
Velvetleaf	90	80	90	65	80	40
Watergrass 2	-	-	-	-	-	-
Wheat	10	0	0	0	10	0
Wild buckwheat	0	0	80	0	0	0
Wild oat	0	0	0	10	20	0

Rate	4 g/ha	COMPOUND					
		9	10	22	25	26	44
PREEMERGENCE							
Barley Igri		0	0	0	0	0	0
Barnyardgrass		0	0	0	0	0	0
Bedstraw		0	0	0	0	0	0
Blackgrass		0	0	0	0	0	0
Chickweed		30	0	0	20	60	0
Cocklebur		0	0	0	0	0	0
Corn		0	0	0	0	0	0
Cotton		0	0	0	0	0	0
Crabgrass		0	0	10	10	0	0
Downy Brome		0	0	0	0	0	0
Giant foxtail		0	0	0	0	0	0
Italn. Ryegrass		0	0	0	0	0	0
Johnsongrass		0	0	0	0	0	0
Lambsquarter		80	60	0	80	-	0
Morningglory		0	0	0	0	0	0
Rape		0	0	0	0	0	0
Redroot Pigweed		0	0	0	0	0	0
Soybean		0	0	0	0	0	0
Speedwell		60	0	0	10	-	0
Sugar beet		0	0	0	0	0	20
Velvetleaf		40	30	0	0	0	0
Wheat		0	0	0	0	0	0
Wild buckwheat		0	0	0	0	0	0
Wild oat		0	0	0	0	0	0

TEST C

Seeds of barnyardgrass (*Echinochloa crus-galli*), bindweed (*Convolvulus arvensis*), black nightshade (*Solanum ptycanthum dunal*), cassia (*Cassia obtusifolia*), 5 cocklebur (*Xanthium strumarium*), common ragweed (*Ambrosia artemisiifolia*), corn (*Zea mays*), cotton (*Gossypium hirsutum*), crabgrass (*Digitaria* spp.), fall panicum (*Panicum dichotomiflorum*), giant foxtail (*Setaria faberii*), green foxtail (*Setaria viridis*), jimsonweed (*Datura stramonium*), johnsongrass (*Sorghum halepense*), lambsquarter (*Chenopodium album*), morningglory (*Ipomoea* spp.), pigweed (10 *Amaranthus retroflexus*), prickly sida (*Sida spinosa*), shattercane (*Sorghum vulgare*), signalgrass (*Brachiaria platyphylla*), smartweed (*Polygonum pensylvanicum*), soybean

(*Glycine max*), sunflower (*Helianthus annuus*), velvetleaf (*Abutilon theophrasti*), wild proso (*Panicum miliaceum*), woolly cupgrass (*Eriochloa villosa*), yellow foxtail (*Setaria lutescens*) and purple nutsedge (*Cyperus rotundus*) tubers were planted into a sandy

5 loam or clay loam soil. These crops and weeds were grown in the greenhouse until the plants ranged in height from two to eighteen cm (one to four leaf stage), then treated postemergence with the test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant. Pots receiving preemergence treatments were planted immediately prior to test chemical application. Pots treated in this fashion were placed in the greenhouse and maintained according to routine greenhouse procedures.

10 Treated plants and untreated controls were maintained in the greenhouse approximately 14-21 days after application of the test compound. Visual evaluations of plant injury responses were then recorded. Plant response ratings, summarized in Table C, are reported on a 0 to 100 scale where 0 is no effect and 100 is complete control.

15

TABLE C COMPOUND

Rate 35 g/ha 20

POSTEMERGENCE

Barnyardgrass	100
Bindweed	90
Blk Nightshade	100
Cocklebur	100
Corn	5
Cotton	90
Crabgrass	100
Fall Panicum	100
Giant Foxtail	50
Green Foxtail	100
Jimsonweed	100
Johnson Grass	50
Lambsquarter	100
Morningglory	70
Nutsedge	70
Pigweed	100
Prickly Sida	60
Ragweed	90
Shattercane	90
Signalgrass	90
Smartweed	100
Soybean	100
Sunflower	95
Velvetleaf	100
Wild Proso	100
Woolly cupgrass	90
Yellow Foxtail	100

TABLE C COMPOUND

Rate 17 g/ha 20

POSTEMERGENCE

Barnyardgrass	90
Bindweed	80
Blk Nightshade	100
Cocklebur	100
Corn	5
Cotton	90
Crabgrass	85
Fall Panicum	100
Giant Foxtail	30
Green Foxtail	85
Jimsonweed	100
Johnson Grass	40
Lambsquarter	100
Morningglory	40
Nutsedge	40
Pigweed	90
Prickly Sida	45
Ragweed	80
Shattercane	30
Signalgrass	80
Smartweed	100
Soybean	90
Sunflower	90
Velvetleaf	100
Wild Proso	100
Woolly cupgrass	85
Yellow Foxtail	80

TABLE C COMPOUND

Rate 8 g/ha 20

POSTEMERGENCE

Barnyardgrass	60
Bindweed	70
Blk Nightshade	100
Cocklebur	100
Corn	0
Cotton	85
Crabgrass	85
Fall Panicum	100
Giant Foxtail	20
Green Foxtail	30
Jimsonweed	100
Johnson Grass	10
Lambsquarter	100
Morningglory	30
Nutsedge	5
Pigweed	80
Prickly Sida	20
Ragweed	80
Shattercane	10
Signalgrass	40
Smartweed	80
Soybean	80
Sunflower	90
Velvetleaf	100
Wild Proso	100
Woolly cupgrass	10
Yellow Foxtail	60

TABLE C COMPOUND

Rate 4 g/ha 20

POSTEMERGENCE

Barnyardgrass	40
Bindweed	50
Blk Nightshade	100
Cocklebur	100
Corn	0
Cotton	60
Crabgrass	20
Fall Panicum	50
Giant Foxtail	0
Green Foxtail	0
Jimsonweed	100
Johnson Grass	5
Lambsquarter	90
Morningglory	0
Nutsedge	0
Pigweed	70
Prickly Sida	0
Ragweed	80
Shattercane	0
Signalgrass	0
Smartweed	80
Soybean	75
Sunflower	85
Velvetleaf	90
Wild Proso	100
Woolly cupgrass	10
Yellow Foxtail	40

TEST D

Compounds evaluated in this test were formulated in a non-phytotoxic solvent mixture which included a surfactant and applied to the soil surface before plant seedlings emerged (preemergence application) and to plants that were grown for various periods of time before treatment (postemergence application). A sandy loam soil was used for the preemergence test while a mixture of sandy loam soil and greenhouse potting mix in

a 60:40 ratio was used for the postemergence test. Test compounds were applied within approximately one day after planting seeds for the preemergence test.

Plantings of these crops and weed species were adjusted to produce plants of appropriate size for the postemergence test. All plant species were grown using normal greenhouse practices. Crop and weed species include American black nightshade (*Solanum americanum*), arrowleaf sida (*Sida rhombifolia*), barnyardgrass (*Echinochloa crus-galli*), cocklebur (*Xanthium strumarium*), common lambsquarters (*Chenopodium album*), common ragweed (*Ambrosia artemisiifolia*), corn (*Zea mays*), cotton (*Gossypium hirsutum*), eastern black nightshade (*Solanum ptycanthum*), fall panicum (*Panicum dichotomiflorum*), field bindweed (*Convolvulus arvensis*), Florida beggarweed (*Desmodium purpureum*), giant foxtail (*Setaria faberii*), hairy beggarticks (*Bidens pilosa*), ivyleaf morningglory (*Ipomoea hederacea*), johnsongrass (*Sorghum halepense*), ladysthumb (*Polygonum persicaria*), large crabgrass (*Digitaria sanguinalis*), purple nutsedge (*Cyperus rotundus*), redroot pigweed (*Amaranthus retroflexus*), soybean (*Glycine max*), surinam grass (*Brachiaria decumbens*), velvetleaf (*Abutilon theophrasti*) and wild poinsettia (*Euphorbia heterophylla*). Treated plants and untreated controls were maintained in a greenhouse for approximately 14 to 21 days, after which all treated plants were compared to untreated controls and visually evaluated. Plant response ratings, summarized in Table D, were based upon a 0 to 100 scale where 0 was no effect and 100 was complete control. A dash response (-) means no test result.

TABLE D	COMPOUND	Rate	140 g/ha	21	22
POSTEMERGENCE					
Arrowleaf Sida		50	60		
Barnyardgrass		100	100		
Cocklebur		90	90		
Common Ragweed		80	95		
Corn		20	20		
Cotton		80	95		
Estrn Blknight		100	100		
Fall Panicum		100	100		
Field Bindweed		10	0		
Fl Beggarweed		-	100		
Giant Foxtail		100	100		
Hairy Beggartic		70	85		
Ivyleaf Mrnglry		10	80		
Johnsongrass		70	15		
Ladysthumb		80	100		
Lambsquarters		90	100		
Large Crabgrass		100	100		
Purple Nutsedge		60	70		
Redroot Pigweed		85	90		
Soybean		90	95		
Surinam Grass		90	75		
Velvetleaf		95	100		
Wild Poinsettia		70	95		

TABLE D	COMPOUND	Rate	70 g/ha	21	22
POSTEMERGENCE					
Arrowleaf Sida		10	5		
Barnyardgrass		95	95		
Cocklebur		90	95		
Common Ragweed		-	90		
Corn		10	5		
Cotton		85	90		
Estrn Blknight		100	100		
Fall Panicum		100	100		
Field Bindweed		10	0		
Fl Beggarweed		95	90		
Giant Foxtail		95	100		
Hairy Beggartic		70	80		
Ivyleaf Mrnglry		0	70		
Johnsongrass		50	15		
Ladysthumb		80	100		
Lambsquarters		90	90		
Large Crabgrass		100	95		
Purple Nutsedge		40	70		
Redroot Pigweed		80	90		
Soybean		90	90		
Surinam Grass		85	60		
Velvetleaf		95	100		
Wild Poinsettia		60	85		

TABLE D COMPOUND

Rate	35 g/ha	21	22
POSTEMERGENCE			
Arrowleaf Sida	5	5	
Barnyardgrass	95	60	
Cocklebur	90	90	
Common Ragweed	70	90	
Corn	10	0	
Cotton	70	90	
Estrn Blknight	100	100	
Fall Panicum	95	90	
Field Bindweed	-	0	
Fl Beggarweed	75	-	
Giant Foxtail	85	90	
Hairy Beggartlic	50	70	
Ivyleaf Mrnglry	5	65	
Johnsongrass	35	5	
Ladysthumb	-	100	
Lambsquarters	90	90	
Large Crabgrass	95	80	
Purple Nutsedge	40	50	
Redroot Pigweed	80	85	
Soybean	75	80	
Surinam Grass	70	30	
Velvetleaf	80	90	
Wild Poinsettia	5	70	

TABLE D COMPOUND

Rate	17 g/ha	21	22
POSTEMERGENCE			
Arrowleaf Sida	0	5	
Barnyardgrass	75	60	
Cocklebur	80	85	
Common Ragweed	40	70	
Corn	10	0	
Cotton	65	80	
Estrn Blknight	100	100	
Fall Panicum	70	85	
Field Bindweed	0	0	
Fl Beggarweed	80	70	
Giant Foxtail	60	75	
Hairy Beggartlic	20	30	
Ivyleaf Mrnglry	0	60	
Johnsongrass	15	0	
Ladysthumb	70	60	
Lambsquarters	80	80	
Large Crabgrass	85	60	
Purple Nutsedge	0	40	
Redroot Pigweed	-	80	
Soybean	65	75	
Surinam Grass	30	10	
Velvetleaf	80	80	
Wild Poinsettia	5	30	

TABLE D COMPOUND

Rate	8 g/ha	21	22
POSTEMERGENCE			
Arrowleaf Sida		0	5
Barnyardgrass		50	25
Cocklebur		70	80
Common Ragweed		40	10
Corn		0	0
Cotton		40	60
Estrn Blknight		80	100
Fall Panicum		50	80
Field Bindweed		0	0
Fl Beggarweed		5	40
Giant Foxtail		50	45
Hairy Beggartic		0	30
Ivyleaf Mrnglry		0	40
Johnsongrass		15	0
Ladysthumb		50	-
Lambsquarters		40	70
Large Crabgrass		80	40
Purple Nutsedge		0	0
Redroot Pigweed		40	50
Soybean		50	50
Surinam Grass		10	5
Velvetleaf		70	60
Wild Poinsettia		5	5

TEST E

Seeds, tubers, or plant parts of alexandergrass (*Brachiaria plantaginea*), alfalfa (*Medicago sativa*), bermudagrass (*Cynodon dactylon*), broadleaf signalgrass (*Brachiaria plantyphylla*), common purslane (*Portulaca oleracea*), common ragweed (*Ambrosia elatior*), cotton (*Gossypium hirsutum*), dallisgrass (*Paspalum dilatatum*), goosegrass (*Eleusine indica*), guineagrass (*Panicum maximum*), itchgrass (*Rottboellia exaltata*), johnson grass (*Sorghum halepense*), large crabgrass (*Digitaria sanguinalis*), peanuts (*Arachis hypogaea*), pitted morningglory (*Ipomoea lacunosa*), purple nutsedge (*Cyperus rotundus*), sandbur (*Cenchrus echinatus*), sourgrass (*Trichachne insularis*), surinam grass (*Brachiaria decumbens*) and texas panicum (*Panicum Texas*) were planted into greenhouse pots of flats containing greenhouse planting medium. Plant species were

grown in separate pots or individual compartments. Preemergence applications were made within one day of planting the seed or plant part. Postemergence applications were applied when the plants were in the two to four leaf stage (three to twenty cm).

5 Test chemicals were formulated in a non-phytotoxic solvent mixture which included a surfactant and applied preemergence and postemergence to the plants. Untreated control plants and treated plants were placed in the greenhouse and visually evaluated for injury 13 to 21 days after herbicide application. Plant response ratings, summarized in Table E, are based on a 0 to 100 scale where 0 is no injury and 100 is complete control. A dash (-) response means no test result.

10

TABLE E COMPOUND

Rate 250 g/ha 20

POSTEMERGENCE

Alexandergrass 80

Bermudagrass 65

Brdlf Sgnlgrass 65

Cmn Purslane 75

Cmn Ragweed 65

Cotton 95

Dallisgrass 70

Goosegrass 45

Guineagrass 25

Itchgrass 50

Johnson grass 55

Large Crabgrass 85

Peanuts 40

Pit Morninglory 55

Purple Nutsedge 65

Sandbur 85

Sourgrass 65

Surinam grass 65

TABLE E COMPOUND

Rate 125 g/ha 20

POSTEMERGENCE

Alexandergrass 65

Bermudagrass 55

Brdlf Sgnlgrass 50

Cmn Purslane 70

Cmn Ragweed 60

Cotton 55

Dallisgrass 55

Goosegrass 40

Guineagrass 15

Itchgrass 10

Johnson grass 45

Large Crabgrass 70

Peanuts 40

Pit Morninglory 0

Purple Nutsedge 50

Sandbur 65

Sourgrass 65

Surinam grass 45

TABLE E COMPOUND

Rate 64 g/ha	20
POSTEMERGENCE	
Alexandergrass	35
Bermudagrass	40
Brdlf Sgnlgrass	40
Cmn Purslane	70
Cmn Ragweed	35
Cotton	45
Dallisgrass	45
Goosegrass	20
Guineagrass	10
Itchgrass	0
Johnson grass	30
Large Crabgrass	60
Peanuts	35
Pit Morning glory	0
Purple Nutsedge	25
Sandbur	30
Sourgrass	55
Surinam grass	35

TABLE E COMPOUND

Rate 64 g/ha	20
PREEMERGENCE	
Alexandergrass	95
Bermudagrass	90
Brdlf Sgnlgrass	0
Cmn Purslane	90
Cmn Ragweed	80
Cotton	0
Dallisgrass	40
Goosegrass	-
Guineagrass	0
Itchgrass	0
Johnson grass	15
Large Crabgrass	30
Peanuts	75
Pit Morning glory	65
Purple Nutsedge	0
Sourgrass	100
Surinam grass	5

TABLE E COMPOUND

Rate 32 g/ha 20

POSTEMERGENCE

Alexandergrass	100
Bermudagrass	80
Brdlf Sgnlgrass	75
Cmn Purslane	98
Cmn Ragweed	60
Cotton	100
Dallisgrass	80
Goosegrass	65
Guineagrass	20
Itchgrass	20
Johnson grass	25
Large Crabgrass	90
Peanuts	60
Pit Morningglory	90
Purple Nutsedge	80
Sandbur	95
Sourgrass	80
Surinam grass	65

TABLE E COMPOUND

Rate 32 g/ha 20

PREEMERGENCE

Alexandergrass	50
Bermudagrass	95
Brdlf Sgnlgrass	0
Cmn Purslane	90
Cmn Ragweed	30
Cotton	0
Dallisgrass	20
Goosegrass	0
Guineagrass	0
Itchgrass	0
Johnson grass	0
Large Crabgrass	30
Peanuts	40
Pit Morningglory	30
Purple Nutsedge	0
Sourgrass	98
Surinam grass	0

TABLE E COMPOUND

Rate 16 g/ha	20
POSTEMERGENCE	
Alexandergrass	100
Bermudagrass	60
Brdlf Sgnlgrass	0
Cmn Purslane	98
Cmn Ragweed	90
Cotton	80
Dallisgrass	80
Goosegrass	50
Guineagrass	5
Itchgrass	5
Johnson grass	10
Large Crabgrass	90
Peanuts	10
Pit Morninglory	75
Purple Nutsedge	30
Sandbur	70
Sourgrass	75
Surinam grass	50

TABLE E COMPOUND

Rate 16 g/ha	20
PREEMERGENCE	
Alexandergrass	0
Bermudagrass	50
Brdlf Sgnlgrass	0
Cmn Purslane	90
Cmn Ragweed	0
Cotton	0
Dallisgrass	10
Goosegrass	0
Guineagrass	0
Itchgrass	0
Johnson grass	0
Large Crabgrass	10
Peanuts	40
Pit Morninglory	80
Purple Nutsedge	0
Sourgrass	98
Surinam grass	0

TABLE E COMPOUND

Rate 8 g/ha	20
POSTEMERGENCE	
Alexandergrass	0
Bermudagrass	0
Brdlf Sgnlgrass	0
Cmn Purslane	0
Cmn Ragweed	0
Cotton	10
Dallisgrass	0
Goosegrass	0
Guineagrass	0
Itchgrass	0
Johnson grass	0
Large Crabgrass	0
Peanuts	0
Pit Morninglory	75
Purple Nutsedge	0
Sandbur	0
Sourgrass	0
Surinam grass	0

TABLE E COMPOUND

Rate 8 g/ha	20
PREEMERGENCE	
Alexandergrass	0
Bermudagrass	0
Brdlf Sgnlgrass	0
Cmn Purslane	0
Cmn Ragweed	0
Cotton	0
Dallisgrass	0
Goosegrass	0
Guineagrass	0
Itchgrass	0
Johnson grass	0
Large Crabgrass	0
Peanuts	0
Pit Morninglory	70
Purple Nutsedge	0
Sourgrass	75
Surinam grass	0

TEST F

Compounds evaluated in this test were formulated in a non-phytotoxic solvent mixture which includes a surfactant and applied to the soil surface before plant seedlings emerged (preemergence application) and to plants that were in the one-to four leaf stage (postemergence application). A sandy loam soil was used for the preemergence test while a mixture of sandy loam soil and greenhouse potting mix in a 60:40 ratio was used for the postemergence test. Test compounds were applied within approximately one day after planting seeds for the preemergence test.

Plantings of these crops and weed species were adjusted to produce plants of appropriate size for the postemergence test. All plant species were grown using normal greenhouse practices. Crop and weed species include annual bluegrass (*Poa annua*), black nightshade (*Solanum nigra*), blackgrass (*Alopecurus myosuroides*), chickweed (*Stellaria media*), deadnettle (*Lamium amplexicaule*), downy brome (*Bromus tectorum*), field violet (*Viola arvensis*), galium (*Galium aparine*), green foxtail (*Setaria viridis*), jointed goatgrass (*Aegilops cylindrica*), kochia (*Kochia scoparia*), lambsquarters (*Chenopodium album*), little seed canarygrass (*Phalaris minor*), rape (*Brassica napus*),

redroot pigweed (*Amaranthus retroflexus*), ryegrass (*Lolium multiflorum*), scentless chamomile (*Matricaria inodora*), speedwell (*Veronica persica*), spring barley (*Hordeum vulgare* cv. 'Klages'), spring wheat (*Triticum aestivum* cv. 'ERA'), sugar beet (*Beta vulgaris* cv. 'US1'), sunflower (*Helianthus annuus* cv. 'Russian Giant'), wild buckwheat (5) (*Polygonum convolvulus*), wild mustard (*Sinapis arvensis*), wild oat (*Avena fatua*), windgrass (*Apera spica-venti*), winter barley (*Hordeum vulgare* cv. 'Igri') and winter wheat (*Triticum aestivum* cv. 'Talent').

10 Treated plants and untreated controls were maintained in a greenhouse for approximately 21 to 28 days, after which all treated plants were compared to untreated controls and visually evaluated. Plant response ratings, summarized in Table F, are based upon a 0 to 100 scale where 0 is no effect and 100 is complete control. A dash response (-) means no test result.

TABLE F COMPOUND

Rate 750 g/ha 43

POSTEMERGENCE

Annual Bluegrass	60
Blackgrass	-
Blk Nightshade	-
Chickweed	60
Deadnettle	50
Downy brome	50
Field violet	-
Galium	65
Green foxtail	10
Ivy Speedwell	-
Jointed Goatgr.	-
Kochia	45
Lambsquarters	100
LS Canarygrass	-
Redroot Pigweed	20
Russian Thistle	10
Ryegrass	-
Scentless Cham.	50
Spring Barley	0
Wheat (Spring)	0
Wheat (Winter)	0
Wild buckwheat	10
Wild mustard	-
Wild oat	-
Windgrass	-
Winter Barley	0

TABLE F COMPOUND

Rate	250 g/ha	43
POSTEMERGENCE		
Annual Bluegrass	60	
Blackgrass	-	
Blk Nightshade	-	
Chickweed	0	
Deadnettle	30	
Downy brome	-	
Field violet	-	
Galium	50	
Green foxtail	10	
Ivy Speedwell	-	
Jointed Goatgr.	-	
Kochia	30	
Lambsquarters	40	
LS Canarygrass	-	
Redroot Pigweed	10	
Russian Thistle	0	
Ryegrass	-	
Scentless Cham.	50	
Spring Barley	0	
Wheat (Spring)	0	
Wheat (Winter)	0	
Wild buckwheat	30	
Wild mustard	-	
Wild oat	-	
Windgrass	-	
Winter Barley	0	

TABLE F COMPOUND

Rate	125 g/ha	21	22
POSTEMERGENCE			
Annual Bluegrass	100	100	
Blackgrass	30	20	
Blk Nightshade	30	20	
Chickweed	100	100	
Deadnettle	100	100	
Downy brome	100	100	
Field violet	0	5	
Galium	100	100	
Green foxtail	60	70	
Ivy Speedwell	100	100	
Jointed Goatgr.	10	10	
Kochia	70	100	
Lambsquarters	100	100	
LS Canarygrass	30	30	
Redroot Pigweed	100	100	
Russian Thistle	70	80	
Ryegrass	5	20	
Scentless Cham.	100	100	
Spring Barley	20	10	
Wheat (Spring)	30	25	
Wheat (Winter)	30	15	
Wild buckwheat	70	75	
Wild mustard	100	100	
Wild oat	50	70	
Windgrass	20	5	
Winter Barley	20	15	

TABLE F		COMPOUND			TABLE F		COMPOUND		
Rate	62 g/ha	5	21	22	Rate	31 g/ha	5	21	22
POSTEMERGENCE									
Annual Bluegrass	60	100	100		Annual Bluegrass	60	60	55	
Blackgrass	10	20	10		Blackgrass	20	10	2	
Blk Nightshade	15	20	10		Blk Nightshade	10	10	5	
Chickweed	75	75	100		Chickweed	75	75	100	
Deadnettle	65	100	100		Deadnettle	60	100	75	
Downy brome	100	100	100		Downy brome	75	55	70	
Field violet	10	0	0		Field violet	0	0	0	
Galium	100	100	100		Galium	-	-	100	
Green foxtail	55	45	55		Green foxtail	50	35	40	
Ivy Speedwel	70	100	100		Ivy Speedwell	60	100	100	
Jointed Goatgr.	15	0	10		Jointed Goatgr.	10	0	2	
Kochia	35	65	80		Kochia	15	55	70	
Lambsquarters	100	100	100		Lambsquarters	75	100	100	
LS Canarygrass	10	20	20		LS Canarygrass	10	10	20	
Redroot Pigweed	70	60	100		Redroot Pigweed	70	55	85	
Russian Thistle	60	100	80		Russian Thistle	40	60	70	
Ryegrass	5	5	0		Ryegrass	5	0	0	
Scentless Cham.	70	70	75		Scentless Cham.	60	65	65	
Spring Barley	30	10	10		Spring Barley	30	10	0	
Wheat (Spring)	20	20	10		Wheat (Spring)	20	10	5	
Wheat (Winter)	30	20	10		Wheat (Winter)	20	5	0	
Wild buckwheat	30	60	70		Wild buckwheat	25	55	60	
Wild mustard	75	100	100		Wild mustard	70	65	100	
Wild oat	20	30	40		Wild oat	10	10	10	
Windgrass	10	10	2		Windgrass	5	10	2	
Winter Barley	30	15	10		Winter Barley	20	10	10	

TABLE F		COMPOUND			TABLE F		COMPOUND	
Rate	16 g/ha	5	21	22	Rate	8 g/ha	5	
POSTEMERGENCE					POSTEMERGENCE			
Annual Bluegrass	50	60	30		Annual Bluegrass	40		
Blackgrass	10	5	0		Blackgrass	0		
Blk Nightshade	5	10	5		Blk Nightshade	0		
Chickweed	70	65	75		Chickweed	50		
Deadnettle	50	100	100		Deadnettle	40		
Downy brome	60	70	100		Downy brome	60		
Field violet	0	0	0		Field violet	0		
Galium	70	100	100		Galium	60		
Green foxtail	30	25	30		Green foxtail	40		
Ivy Speedwell	50	30	60		Ivy Speedwell	30		
Jointed Goatgr.	0	0	0		Jointed Goatgr.	0		
Kochia	10	10	60		Kochia	0		
Lambsquarters	60	100	100		Lambsquarters	30		
LS Canarygrass	2	10	10		LS Canarygrass	0		
Redroot Pigweed	60	50	50		Redroot Pigweed	50		
Russian Thistle	30	40	50		Russian Thistle	30		
Ryegrass	0	0	0		Ryegrass	0		
Scentless Cham.	60	60	50		Scentless Cham.	50		
Spring Barley	20	10	0		Spring Barley	10		
Wheat (Spring)	15	10	2		Wheat (Spring)	10		
Wheat (Winter)	10	0	0		Wheat (Winter)	0		
Wild buckwheat	0	50	60		Wild buckwheat	0		
Wild mustard	50	65	100		Wild mustard	60		
Wild oat	5	15	0		Wild oat	0		
Windgrass	5	5	2		Windgrass	0		
Winter Barley	10	5	0		Winter Barley	10		

TEST G

Compounds evaluated in this test were formulated in a non-phytotoxic solvent mixture and applied to the surface of the water which was contained in each pot.

5 Individual containers of barnyardgrass (*Echinochloa oryzicola*), small flower umbrella sedge (*Cyperus difformis*), common falsepimpernel (*Lindernia procumbens*), monochoria (*Monochoria vaginalis*) and bulrush (*Scirpus juncoides*) were seeded and allowed to grow until the 1.5 to 2.5 leaf stage of development. A Sultana clay loam soil was used for this propagation. Japonica rice (*Oryza sativa*) was transplanted at 0 and 2

cm depth five days before application of the test compound to the water surface. An early and late stage of each weed species was treated, the stage of development being related to the concurrent planting of *Scirpus juncoides* which was then treated at the 1.5 (early) and the 2.5 (late) leaf stage.

5 Treated plants and untreated controls were maintained under greenhouse conditions for twenty to thirty days at which time treated plants were compared to untreated controls and visually evaluated. Plant response ratings, summarized in Table G, are based upon a 0 to 100 scale where 0 is no effect and 100 is complete control. A dash response (-) indicated that no test result was recorded.

10

TABLE G COMPOUND

Rate	1000 g/ha	37
Flood Saita soil		
barnyard early	100	
barnyard late	70	
C. difformis early	100	
C. difformis late	60	
Japoni rice 0cm	85	
Japoni rice 2cm	80	
L. procumben early	100	
L. procumben late	100	
M. vaginalis early	80	
M. vaginalis late	65	
S. juncoides early	80	
S. juncoides late	55	

TABLE G COMPOUND

Rate	500 g/ha	18	37
Flood Saita soil			
barnyard early	75	65	
barnyard late	55	60	
C. difformis early	100	80	
C. difformis late	80	30	
Japoni rice 0cm	100	50	
Japoni rice 2cm	80	50	
L. procumben early	100	100	
L. procumben late	100	100	
M. vaginalis early	80	65	
M. vaginalis late	75	70	
S. juncoides early	45	60	
S. juncoides late	55	50	

TABLE G COMPOUND

Rate	250 g/ha	18	37	38
Flood Saita soil				
barnyard early	40	65	20	
barnyard late	50	50	20	
C. diffiformis early	40	65	20	
C. diffiformis late	70	40	20	
Japoni rice 0cm	85	10	25	
Japoni rice 2cm	60	0	15	
L. procumben early	100	100	60	
L. procumben late	100	100	40	
M. vaginalis early	65	75	30	
M. vaginalis late	70	55	50	
S. juncoides early	45	40	20	
S. juncoides late	50	30	30	

TABLE G COMPOUND

Rate	125 g/ha	18	37	38
Flood Saita soil				
barnyard early	35	10	20	
barnyard late	35	0	30	
C. diffiformis early	20	20	20	
C. diffiformis late	30	10	40	
Japoni rice 0cm	45	0	5	
Japoni rice 2cm	5	10	15	
L. procumben early	100	70	20	
L. procumben late	100	100	50	
M. vaginalis early	70	30	10	
M. vaginalis late	55	30	40	
S. juncoides early	35	10	30	
S. juncoides late	40	0	40	

TABLE G COMPOUND

Rate	64 g/ha	18	38
Flood Saita soil			
barnyard early	30	20	
barnyard late	30	10	
C. diffiformis early	0	20	
C. diffiformis late	10	10	
Japoni rice 0cm	25	10	
Japoni rice 2cm	0	0	
L. procumben early	100	50	
L. procumben late	100	20	
M. vaginalis early	60	10	
M. vaginalis late	60	30	
S. juncoides early	20	30	
S. juncoides late	20	20	

TABLE G COMPOUND

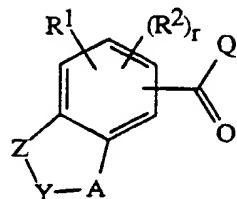
Rate	32 g/ha	38
Flood Saita soil		
barnyard early	10	
barnyard latete	20	
C. diffiformis early	30	
C. diffiformis late	10	
Japoni rice 0cm	5	
Japoni rice 2cm	5	
L. procumben early	20	
L. procumben late	-	
M. vaginalis early	20	
M. vaginalis late	40	
S. juncoides early	30	
S. juncoides late	30	

CLAIMS

What is claimed is:

1. A compound selected from Formula I, and agriculturally suitable salts thereof,

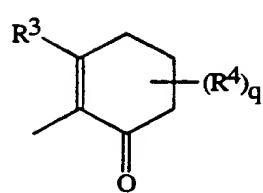
5



I

wherein

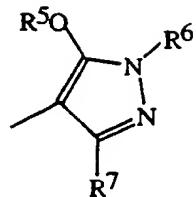
Q is



10

Q-1

or



Q-2

15

A is $-(CH_2)_m-$, $-CH=CH-$, $-CH_2CH=CH-$, $-CH=CHCH_2-$, $-(CH_2)_n-NR^9-$, $-NR^9-(CH_2)_n-$, $-(CH_2)_n-O-$ or $-(CH_2)_n-S(O)_2-$, each group optionally substituted with one to four R⁸, and the directionality of the A linkage is defined such that the moiety depicted on the left side of the linkage is bonded to Y and the moiety on the right side of the linkage is bonded to the phenyl ring;

20

Y is O; NR⁹; or CH₂ optionally substituted with one or two groups independently selected from C₁-C₆ alkyl, C₁-C₆ haloalkyl and halogen; provided that when A is $-NR^9-(CH_2)_n-$, then Y is CH₂;

25

Z is C(=X), O, or S(O)₂; provided that when Y is O or NR⁹, then Z is C(=X); X is O or S;

R¹ is H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, halogen, cyano, nitro, S(O)₂NR¹⁰R¹¹, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₃-C₆ alkenylsulfonyl, C₃-C₆ haloalkenylsulfonyl, C₃-C₆ alkynylsulfonyl, C₃-C₆ haloalkynylsulfonyl or C₃-C₆ cycloalkylsulfonyl; or R¹ is

phenylsulfonyl optionally substituted with C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, 1-2 halogen, cyano or nitro; each R² is independently C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, halogen, cyano or nitro;

5 R³ is OR¹², C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl or halogen; each R⁴ is independently C₁-C₃ alkyl, C₁-C₃ alkoxy, C₁-C₃ alkylthio or halogen; or when two R⁴ are attached to the same carbon atom, then said R⁴ pair can be taken together to form -OCH₂CH₂O-, -OCH₂CH₂CH₂O-, -SCH₂CH₂S- or -SCH₂CH₂CH₂S-, each group optionally substituted with 1-4 CH₃;

10 R⁵ is H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkoxyalkyl, formyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxy carbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₇ dialkylaminocarbonyl, C₁-C₆ alkylsulfonyl or C₁-C₆ haloalkylsulfonyl; or R⁵ is benzoyl or phenylsulfonyl, each optionally substituted with C₁-C₃ alkyl, halogen, cyano or nitro;

15 R⁶ is H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ alkenyl or C₃-C₆ alkynyl; or R⁶ is phenyl or benzyl, each optionally substituted on the phenyl ring with C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, 1-2 halogen, cyano or nitro;

20 R⁷ is H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, halogen, cyano or nitro; each R⁸ is independently C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, hydroxy or halogen; or two R⁸ groups bonded to the same carbon atom can be taken together with the carbon to which they are attached to form C(=O) or C(=S); provided that when two R⁸ groups are attached to a carbon atom which is attached to an O, NR⁹ or S(O)₂, then no more than one of said R⁸ groups can be C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, hydroxy or halogen;

25 R⁹ is independently H; C₁-C₆ alkyl; C₁-C₆ haloalkyl; C₃-C₆ alkenyl; C₃-C₆ haloalkenyl; C₃-C₆ alkynyl; C₃-C₆ haloalkynyl; C₃-C₆ cycloalkyl; C₁-C₆ alkoxy; C₁-C₆ haloalkoxy; C₂-C₆ alkoxyalkyl; formyl; C₂-C₆ alkylcarbonyl; C₂-C₆ alkoxy carbonyl; C₂-C₆ alkylaminocarbonyl; C₃-C₇ dialkylaminocarbonyl; or phenyl, benzyl or benzoyl, each optionally substituted on the phenyl ring with C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, 1-2 halogen, cyano or nitro;

30 R¹⁰ is H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ alkenyl, C₃-C₆ haloalkenyl, C₃-C₆ alkynyl, C₃-C₆ haloalkynyl, C₃-C₆ cycloalkyl or C₁-C₆ alkoxy; or R¹⁰ is phenyl or benzyl, each optionally substituted on the phenyl ring with C₁-C₃

35

R¹⁰ is H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ alkenyl, C₃-C₆ haloalkenyl, C₃-C₆ alkynyl, C₃-C₆ haloalkynyl, C₃-C₆ cycloalkyl or C₁-C₆ alkoxy; or R¹⁰ is phenyl or benzyl, each optionally substituted on the phenyl ring with C₁-C₃

alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, 1-2 halogen, cyano or nitro;

R¹¹ is H, C₁-C₆ alkyl or C₁-C₆ haloalkyl; or

R¹⁰ and R¹¹ can be taken together as -CH₂CH₂-, -CH₂CH₂CH₂-,
5 -CH₂CH₂CH₂CH₂-, -CH₂CH₂CH₂CH₂CH₂- or -CH₂CH₂OCH₂CH₂-, each optionally substituted with 1-4 C₁-C₃ alkyl;

R¹² is H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkoxyalkyl, formyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxy carbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₇ dialkylaminocarbonyl, C₁-C₆ alkylsulfonyl or C₁-C₆ haloalkylsulfonyl; or R¹² 10 is benzoyl or phenylsulfonyl, each optionally substituted with C₁-C₃ alkyl, halogen, cyano or nitro;

m is 1, 2 or 3;

n is 1 or 2;

q is 0, 1, 2, 3 or 4; and

15 r is 0, 1 or 2;

provided that

(i) when Z is C(=X) or O; A is -(CH₂)_m- optionally substituted with one to four R⁸; and m is 1 or 2; then Q is Q-2;

(ii) when Z is C(=X) or O; and A is -CH=CH- optionally substituted with one to 20 two R⁸; then Q is Q-2;

(iii) when Z is C(=X) or O; A is -(CH₂)_n-NR⁹-, -NR⁹-(CH₂)_n- or -(CH₂)_n-O- each optionally substituted with one to four R⁸; and n is 1; then Q is Q-2;

(iv) when A is -(CH₂)_n-NR⁹-, -(CH₂)_n-O- or -(CH₂)_n-S(O)₂- each optionally 25 substituted with one to four R⁸; and Y is CH₂ optionally substituted with one or two groups independently selected from C₁-C₆ alkyl, C₁-C₆ haloalkyl and halogen; then Z is O or S(O)₂;

(v) when A is -(CH₂)_m- optionally substituted with one to four R⁸; Y is CH₂ 30 optionally substituted with one or two groups independently selected from C₁-C₆ alkyl, C₁-C₆ haloalkyl and halogen; and Z is O or S(O)₂; then each R⁸ is independently C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, hydroxy or halogen provided that no more than one R⁸ is C₁-C₆ alkoxy; and

(vi) when A is -(CH₂)_m- optionally substituted with one to four R⁸; Y is CH₂ 35 optionally substituted with one or two groups independently selected from C₁-C₆ alkyl, C₁-C₆ haloalkyl and halogen; Z is S(O)₂; and m is 2; then Q is Q-1 and each R⁸ is independently C₁-C₆ alkyl, C₁-C₆ haloalkyl, hydroxy or halogen.

2. A compound of Claim 1 wherein:

the A-Y-Z moiety is selected from combinations of A, Y and Z such that

(i) when A is $-(CH_2)_m$ - optionally substituted with one to two R⁸ and Y is O or NR⁹, then Z is C(=X);

(ii) when A is $-(CH_2)_m$ - optionally substituted with one to two R⁸ and Y is CH₂ optionally substituted with one or two groups independently selected from C₁-C₆ alkyl, C₁-C₆ haloalkyl and halogen, then Z is O; and

(iii) when A is $-(CH_2)_m$ - or $-(CH_2)_n$ -NR⁹- optionally substituted with one to two R⁸ and Y is CH₂ optionally substituted with one or two groups independently selected from C₁-C₆ alkyl, C₁-C₆ haloalkyl and halogen, then Z is S(O)₂;

10 X is O;

each R⁴ is independently C₁-C₃ alkyl;

R⁶ is H, C₁-C₆ alkyl or C₃-C₆ alkenyl;

R⁷ is H, C₁-C₃ alkyl or C₁-C₃ haloalkyl;

R⁹ is H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ alkenyl, C₃-C₆ alkynyl or C₃-C₆ cycloalkyl;

R¹² is H, formyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxy carbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₇ dialkylaminocarbonyl, C₁-C₆ alkylsulfonyl or C₁-C₆ haloalkylsulfonyl; or R¹² is benzoyl or phenylsulfonyl, each optionally substituted with C₁-C₃ alkyl, halogen, cyano or nitro;

20 q is 0, 1 or 2; and

r is 0 or 1.

3. A compound of Claim 2 wherein:

R¹ is H, methyl, halogen, S(O)₂NR¹⁰R¹¹, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl or C₃-C₅ cycloalkylsulfonyl;

25 R² is methyl, halogen or nitro;

R³ is OR¹²;

R⁵ is H or C₁-C₃ alkylsulfonyl; or R⁵ is benzoyl or phenylsulfonyl, each optionally substituted with C₁-C₃ alkyl, halogen, cyano or nitro;

30 each R⁸ is independently C₁-C₃ alkyl, C₁-C₃ alkoxy or halogen; or two R⁸ groups bonded to the same carbon atom can be taken together with the carbon to which they are attached to form C(=O);

R¹⁰ is H, C₁-C₄ alkyl, allyl or propargyl;

R¹¹ is H or C₁-C₄ alkyl; and

35 R¹² is H or C₁-C₃ alkylsulfonyl; or R¹² is benzoyl or phenylsulfonyl, each optionally substituted with C₁-C₃ alkyl, halogen, cyano or nitro.

4. The compound of Claim 3 which is selected from the group:

2-(1,1-dimethylethyl)-5-[(1-ethyl-5-hydroxy-1H-pyrazol-4-yl)carbonyl]-8-(ethylsulfonyl)-3,4-dihydro-1(2H)-isoquinolinone;

(2,3-dihydro-2,4,7-trimethylbenzo[*b*]thiophen-5-yl)(1-ethyl-5-hydroxy-1*H*-pyrazol-4-yl)methanone *S,S*-dioxide;

(1-ethyl-5-hydroxy-1*H*-pyrazol-4-yl)(2,3,4,5-tetrahydro-6,9-dimethyl-1-benzothiepin-7-yl)methanone *S,S*-dioxide;

5 4-ethyl-6-[(2-hydroxy-6-oxo-1-cyclohexen-1-yl)carbonyl]-2*H*-1,4-benzothiazin-3(4*H*)-one 1,1-dioxide;

4-ethyl-6-[(2-hydroxy-6-oxo-1-cyclohexen-1-yl)carbonyl]-5,8-dimethyl-2*H*-1,4-benzothiazin-3(4*H*)-one 1,1-dioxide; and

10 (2,3-dihydro-2,4,7-trimethylbenzo[*b*]thiophen-5-yl)(5-hydroxy-1-methyl-1*H*-pyrazol-4-yl)methanone *S,S*-dioxide.

5. A herbicidal composition comprising a herbicidally effective amount of a compound of Claim 1 and at least one of a surfactant, a solid diluent or a liquid diluent.

6. A method for controlling the growth of undesired vegetation comprising contacting the vegetation or its environment with a herbicidally effective amount of a

15 compound of Claim 1.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 96/13347

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6	C07D335/06	A01N43/08	A01N43/10	A01N43/18	A01N43/22
	A01N43/38	A01N43/42	A01N43/84	A01N43/56	C07D279/16
	C07D333/54	C07D337/08	C07D401/06	C07D403/06	C07D405/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 283 261 A (ICI PLC ;ICI AMERICA INC (US)) 21 September 1988 cited in the application see page 57 - page 58; claim 1 see page 62; claim 11 ---	1-6
X	WO 95 04054 A (IDEMITSU KOSAN CO ;NAKAMURA KAZUFUMI (JP); KOIKE KAZUYOSHI (JP); S) 9 February 1995 cited in the application & EP 0 712 853 A (IDEMITSU KOSAN COMPANY LIMITED) 22 May 1996 see page 45 - page 47; claims 1,10 ---	1-6
P,X	---	-/-

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
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1

Date of the actual completion of the international search	Date of mailing of the international search report
29 November 1996	5.12.96
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Authorized officer Fink, D

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 96/13347

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C07D409/06 C07D417/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 94 04524 A (IDEMITSU KOSAN CO ; SAKAMOTO MASASHI (JP); SHIBATA MITSURU (JP); NA) 3 March 1994	1-6
P,X	& US 5 480 858 A (M. SAKAMOTO ET AL.) 2 January 1996 see column 28 - column 29; claims 1,3 ----	1-6
X	WO 93 18031 A (IDEMITSU KOSAN CO) 16 September 1993	1-6
P,X	& US 5 468 722 A (M. SHIBATA ET AL.) 21 November 1995 see column 80; claims 1,7 -----	1-6

Further documents are listed in the continuation of box C.

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'&' document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 96/13347

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